THE MATHEMATICS TEACHER

DEC 5 1938

Volume XXXI DECEMBER · 1938 Number 8

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PUBLISHED BY THE
NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS
MENASHA, WISCONSIN · NEW YORK, N.Y.

Entered as second-class matter at the post office at Menasha, Wisconsin. Acceptance for mailing at special rate of postage provided for in the Act of February 28, 1925, embodied in paragraph 4, section 412, P. L. & R., authorized March 1, 1930.

THE MATHEMATICS TEACHER

Official Journal of the National Council of Teachers of Mathematics

Devoted to the Interests of mathematics in Elementary and Secondary Schools

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THE MATHEMATICS TEACHER
525 West 120th St., New York City (Editorial Office)

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SUBSCRIPTION PRICE $2.00 PER YEAR (*Eight issues*)

Foreign postage, 50 cents per year; Canadian postage, 25 cents per year. Single copies 25 cents. Remittances should be made by Post Office Money Order, Express Order, Bank Draft or personal check and should be payable to THE MATHEMATICS TEACHER.

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THE MATHEMATICS TEACHER

Volume XXXI Number 8

Edited by William David Reeve

Some Debatable Facts and Some Suggestions*

By William L. Hart
University of Minnesota, Minneapolis, Minnesota

1. *Introduction.* On several occasions I have read discussions of the curriculum in secondary mathematics which have commenced with arguments, pro or con, about existing college entrance requirements.[1] More appropriately, I believe, associated collegiate problems should be proposed for solution only after the secondary program is formulated and justified. In particular, in a discussion of secondary mathematics, this viewpoint leads me to label as irrelevant, or misplaced, any preliminary conclusion about college entrance requirements such as follows:[2]

"The practice of selecting students for entrance to college on the basis of the pattern of subjects[3] taken in high school seems to be indefensible and, confronted with the data from these studies, it is hardly possible that the majority of institutions will continue the custom."

In spite of my claim of the irrelevancy of the opinion, in the interest of clear thinking I consider it appropriate to examine the data mentioned as the foundation for such a statement. Accordingly, the main purpose of this paper is to present reasons for a final conjecture that *current evidence does not justify the quoted opinion so far as secondary mathematics is concerned.* Then, for constrast with a discussion in which the opinion is taken as the starting point, near the end of this paper I shall make certain brief suggestions about high school mathematics where any consideration of college entrance requirements would come last rather than first.

2. *Some criticisms of the evidence.* In educational literature we find a large amount of data bearing on the general question "is any required pattern of high school subjects justified as a college entrance requirement?" This question is so broad that I shall restrict my remarks to its mathematical side. Moreover, I insist that the unique position of mathematics as a foundation in various fields demands that entrance requirements in mathematics should be considered wholly apart from the *general* problem of pattern requirements. However, some of the criticisms which I shall advance concerning pertinent educational research would apply to the general problem as well as to

[1] For example, see "Let's Face the Facts," by Harl R. Douglass, *Mathematics Teacher*, Vol. 30, 1937, p. 56.

[2] See Douglass, *loc. cit.*, p. 58.

[3] With special allusion to mathematics.

* Presented under the title, *Trends in Secondary Mathematics and Associated Collegiate Problems*, to the Rocky Mountain Section of the Mathematical Association of America at Greeley, Colorado, April 17, 1937.

the specific case of requirements in mathematics.

In support of the opinion quoted from Douglass in Section 1, he cited an extensive list of statistical investigations in which the characteristic conclusion is that *the collegiate performance of a student is not significantly affected by the quantity of secondary mathematics which he presents at entrance to college.* A carefully prepared piece of this evidence is found in Douglass' own study[4] relating to approximately 400 freshmen who entered the College of Arts or the School of Business Administration at the University of Oregon. To obtain concreteness in several later references, it will be useful to recall certain details of that study. We find that a negligible number (only nine) of the students presented *less* than two years of secondary mathematics, the usual minimum for entrance. Essentially, then, the whole group was concentrated in five categories corresponding, respectively, to 2, $2\frac{1}{2}$, 3, $3\frac{1}{2}$, and 4 units of entrance mathematics. For each student, Douglass computed the average mark obtained in the first two years of college work and, with this measure for collegiate success, he stated two main statistical facts of mathematical significance. First, he found that the median and the quartiles in the distribution of college grades were essentially the same in each category just described. Second, for the whole group, he found that the coefficient of correlation between the number of entrance units in mathematics and the average college grade was $-.02$ and, when computed with intelligence held fast, was $-.13$, both negligible in size. Then, Douglass concluded that there was no significant effect on college performance caused by a variation in the amount of mathematics presented at entrance, and, as a corollary, in the opinion quoted in Section 1 he infers that *no* college entrance requirement in mathematics is justified.

In connection with Douglass' statistical technique, I offer no criticism of his obviously pertinent use of the medians and quartiles of the grade distributions and I shall not object to any general conclusions which they might properly justify. However, I wish to question very seriously his use of simple correlation coefficients[5] in support of these conclusions. In spite of Douglass' division of the Oregon students into five categories, ranging from two to four units of entrance mathematics, I observe that a more appropriate division would specify just *two* categories, corresponding, respectively, to *two* units and to *more than two* units of secondary mathematics. For, in the average university where two units of entrance mathematics is the usual minimum, beyond the two unit stage we find that the essentially useful course for incidental purposes in satisfying intangible prerequisites is advanced high school algebra, which usually is the first increment of one half unit[6] beyond high school geometry. Additional entrance credit in solid geometry or still more advanced algebra could have at most negligible general effect on the collegiate performance of the students because omission of such content would be subject to immediate correction through college courses whenever the content became essential. Hence, I observe that Douglass used an ordinary coefficient of correlation as a measure of relationship where one of his variables, the units of entrance mathematics, took on just *five* values (and, in fact, only three important values) and where, by my subjective decision, I have

[4] See Harl R. Douglass, *The Relation of High School Preparation and Certain Other Factors to Academic Success at the University of Oregon*, University of Oregon Publications, Vol. III, Part 1, Chapter V, September, 1931.

[5] Douglass himself has stated that these coefficients must not be taken too literally, because of the small spread in the values for one variable, the entrance units. The remarks in the present paper are more emphatic, because of a subjective opinion which reduces this spread.

[6] Experience leads me to conclude that this second exposure to algebra has a large influence on a student's mathematical skill although the corresponding increment of one-half unit in his credits seems small.

concluded that this variable gives rise to only *two* distinct categories. In such a setting, the ordinary coefficient of correlation is of extremely doubtful significance. As a general viewpoint, I suggest that it would be appropriate for all interested persons to cease quoting correlation coefficients in investigations like the Oregon case, where *quantity* of entrance mathematics is one variable, and to base conclusions on less debatable technique. This criticism, of course, does not apply to all research on the validity of entrance requirements but does find contact with several pieces of evidence which have been quoted in support of the debatable opinion of Section 1 and throws a distinct cloud over the associated conclusions.

Let me return to the Oregon investigation as an illustrative setting for a more general criticism of the evidence under consideration. Let me again analyze the group of 400 students involved at Oregon into just two categories, those offering *two* units and those offering *more than two* units of mathematics for college entrance. For simplicity, let me assume (probably contrary to fact) that all of the category offering only minimum mathematics eliminated this handicap by taking a college course in algebra during the first college semester and that those in the second category took no college mathematics. Then, it follows that the group of 400 students, who originally where nonhomogeneous with respect to mathematical preparation, became essentially homogeneous after just one semester. Hence, since average grades were taken at the end of a long period, two years, in the Oregon study, it would be a surprising result if any relation had been found between these grades and entrance units in mathematics, regardless of the statistical technique involved. As a corresponding general decision in connection with evidence on the validity of entrance requirements, I choose to give small weight to any statistical investigation where no account is taken of the increasing mathematical homogeneity of the student group.[7] This increase may be due, *first*, to care exercised by the college in protecting courses by prerequisites and, *second*, to provision for collegiate instruction in mathematics to eliminate a possible handicap for students entering with only the legal minimum of secondary mathematics. The present viewpoint becomes particularly pertinent when we observe that the available statistical evidence shows essentially *negative* results, that is, no significant effect on college grades due to quantity of entrance mathematics. In the same direction, I criticize adversely any investigation which leaves out of consideration the effects of unnatural sequence and artificial selection in course programs which may be induced by deficiences in entrance mathematics.

3. *A new interpretation of the statistical facts.* In the evidence relating to the validity of entrance requirements, we find many investigations immune to gross criticism so far as the statistical analysis is concerned. Let me now assume that I am dealing with such a piece of research; for concreteness, suppose again that it is the study relating to the 400 students analyzed at Oregon, with a final conclusion[8] that the performance of the students in college courses did not show significant effects due to the quantity of entrance mathematics. I recall now that essentially all the students offered at least the minimum mathematics expected at entrance. Then, I choose to look upon the investigation of these students as *a test of the accuracy of the adjustment of course prerequisites and grading standards in the college to existing entrance requirements*, rather than a test of their *validity*. Theoretically, such a study could arrive at one of three conclusions: it might discover a *favorable* effect, or *no* effect, or an *unfavorable* effect

[7] I know of no published research on entrance requirements in mathematics which is immune to this criticism.

[8] Reasonably supported by the facts previously mentioned about medians and quartiles in grade distributions.

caused by entrance mathematics *above* the minimum. If an unfavorable effect ever appeared to be demonstrated, I would immediately question the arithmetic and general technique of the investigation because I cannot believe that mathematics above a legal minimum will ever be found harmful.[9] In a case like the Oregon study, where there was no significant effect due to an excess of entrance mathematics over the usual minimum, I conclude that course prerequisites in the university were well adjusted to the minimum entrance requirements. This inference is established by observing that the investigation detected no handicap in college grades among the students offering only the minimum. Personally, I consider this interpretation of the results to be more logical than one throwing doubt on the validity of any particular amount of mathematics as an entrance requirement.

In connection with the third possibility referred to in the preceding paragraph, suppose for illustration that an investigation of the Oregon type has discovered a *favorable* effect on college grades due to an excess of entrance mathematics over the minimum requirement. Then, instead of concluding that this favorable effect *justifies* mathematics as an entrance requirement, I claim that the effect casts *an embarassing reflection on the university's ability to adjust its course prerequisites to existing entrance requirements.* Or, the result of the investigation might be taken to imply that the minimum requirement should be *raised* if course prerequisites are to be *unaltered.* For, with the stated favorable effect on student grades, it would seem that some of the college courses must involve intangible mathematical prerequisites which handicap students who entered the university with minimum preparation in mathematics.

In summary, I conclude that an investigation of the Oregon type might *justify* an existing entrance requirement in mathematics, or might indicate the need for *raising* the requirement, but is not likely to obtain results showing that the requirement should be *lowered.*

The present line of reasoning also leads me to take a critical attitude when an investigation of entrance requirements in one college is supposed to carry force in connection with an entirely separate college. Thus, if an investigator, with data concerning students and courses in college A, succeeds in justifying its entrance requirements in contrast to more restrictive requirements[10] in vogue at college B, I would merely admit that course prerequisites at (A) are well adjusted to *its own entrance requirements.* I would not accept any inference concerning the validity of the higher requirements in use at (B) because none of the data of the investigation is pertinent in connection with courses in that college.

The reasoning of the preceding paragraph has distinct force, for example, in limiting the extent of the inferences to be drawn from a recent test[11] of the validity of entrance requirements in the General College at the University of Minnesota. The specified college is a two-year junior college, with its main focus on general two-year objectives, incorporated in the family of relatively separate colleges making up the University of Minnesota. It is pertinent to note the following facts about the setting for this investigation, which commenced as soon as the General College was organized: (1) the typical course was of the broad survey type, organized uniquely for this college, without formal prerequisites; (2) the grading of students was based on *relative* performance as

[9] To the best of my knowledge, no statistically significant unfavorable effect has ever been met by investigators.

[10] For a study with data of this nature, see R. L. Stinnete, *An Evaluation of the Present College Entrance Requirements at Colorado State Teacher's College*, M.A. Thesis, Colorado State Teacher's College, 1930.

[11] See Henry Kronenberg, *The Validity of Curricular Requirements for Admission to the General College at the University of Minnesota*, Ph.D. Thesis, University of Minnesota, 1935.

shown by percentile ranks in classes; (3) the median student under consideration ranked approximately at the lowest quartile among all freshmen entering the University of Minnesota; (4) in spite of a specified pattern of high school credits as the minimum requirement for entrance to any college of the University of Minnesota, for experimental purposes a considerable number of students were admitted to the General College without the legal pattern, and thus there was established a more lenient extra-legal entrance requirement. In my opinion, Kronenberg demonstrated conclusively that, in the General College, the curriculum and grading standards were well adjusted to the extra-legal minimum which had been put into effect for experimental purposes and hence that there was no valid reason for enforcing the legal pattern[12] in this college. But, this conclusion establishes no corollary concerning the validity of existing entrance requirements in the separate four-year curricula of the University of Minnesota, particularly so far as any mathematical requirement is concerned. Moreover, it is significant that the general conclusions of Kronenberg were strongly negated in the case of the single course in the General College with a mathematical prerequisite (which was ninth grade algebra). Thus, I conclude that practically no weight need be given to the citation[13] of Kronenberg's study in connection with entrance requirements in mathematics except in a junior college of the same type as the General College.

4. *A subjective viewpoint about entrance mathematics.* In order to obtain objective results justifying lower mathematical entrance requirements in any college, it appears essential as a preliminary that a statistically significant number of students should be admitted with less than the existing legal minimum of entrance mathematics. Then, to gather satisfactory data, these students should be forced to take various normal patterns of college course work regardless of any lack of mathematical prerequisites and without any lowering of standards of grading in existence before the experiment was performed. In my opinion, however, any college which would permit such an experiment, with a conclusion probably favoring mathematics, in which helpless students would be treated like guinea pigs, would deserve the heartiest condemnation. My own conclusion is that the mathematical entrance requirement for any college should be decided upon semi-subjectively, with attention to the following considerations: (1) each college department should analyze its explicit and implicit connections with mathematics, objectively if possible, course by course, and should decide on a reasonable level of mathematical preparation which would permit efficiency in the progress of students: (2) the college as a whole should correlate the departmental findings and specify a mathematical entrance requirement which would permit efficient conduct of the college as a whole, with recognition of the need for an appropriately elevated level if essential collegiate objectives are to be attained within a limited time.

In such a consideration of an efficiency level, the mental possibilities as well as the limitations of high school students and the administrative problems of the secondary field would have to be kept in mind. Also, it would be necessary to recognize that, although some departments in a college may have little need for mathe-

[12] In 1936, the Senate of the University of Minnesota repealed its requirement of a specified pattern of high school credits as a minimum on which each independent college in the University might build its own entrance requirements, and now leaves it to each college to decide on all pattern features of its requirements. The General College immediately took advantage of this action to make permanent the type of requirements which had been employed experimentally in connection with the Kronenberg study. The new license granted by the Senate has not as yet been responsible for any change in the entrance requirements in any major four-year curriculum at the University of Minnesota.

[13] Compare Douglass, this journal, *loc. cit.*, p. 58.

matics, nevertheless few rounded curricula can be organized without bringing in implicit or explicit mathematical needs. If a specific requirement in mathematics is finally imposed for unrestricted entrance, it might be desirable for the college to leave a special loophole for conditional entrance or for a restricted type of entrance for students of sufficient intelligence who lack the required credits. Such a restricted alteration of an ironclad mathematical requirement for college entrance is roughly illustrated by the entrance requirements now in force at the University of Wisconsin, where it is interesting to observe how limited a list of major fields is available for the student who enters on a restricted basis due to a mathematical deficiency. When properly analyzed, such a restricted change from ironclad requirements in mathematics supports the opinion that a reasonable amount of secondary mathematics is practically indispensable for student efficiency in college rather than an opinion that there has been a weakening in the position of secondary mathematics as college preparation.

Under the semi-subjective approach to college entrance requirements which has just been suggested, it is apparent that the validity of mathematical requirements in any college is considered essentially dependent on the prerequisites in its courses, the objectives of the college, and the intangible standards which it wishes to apply in evaluating the performance of its students. With each college thus treated as an individual problem, it would not be surprising to find wide variations in the final entrance requirements. But, this viewpoint has features which appear sounder educationally than a blanket acceptance of the statement quoted in Section 1 under which we would infer that mathematical entrance requirements should be eliminated practically everywhere.

5. ***An approach to the secondary curriculum in mathematics.*** Let me now discard all thought of collegiate requirements and consider the extent of the mathematics which should be presented at the secondary level. For brevity, I shall not be concerned with intimate details of content, arrangement, or presentation of subject matter. I assume that, in contrast to the mathematical status quo of the last generation, it is clear that newer viewpoints are essential, mainly because of the increase in high school enrollment from 600,000 in the year 1900 to about 6,500,000 today. As a general principle, I infer that, within reasonable limits, the secondary field has a responsibility for the instruction of every student in the fashion best suited to his brains and his possibilities for useful and enjoyable life as a part of our population. I look at the classical curriculum in secondary mathematics as most likely to be in error under present conditions in so far as the courses would attempt to treat the present enormous student body as one essentially homogeneous intellectual group. My later suggestions as to the curriculum will be phrased so as to avoid a new error of the same type, and perhaps more dangerous socially, such as might occur if a *lowered* type of mathematics were ordained for *all* students. Also, I admit believing that the ninth grade is the latest suitable time in our school system for attempting at least gross differentiation in the curriculum offered to students of good intelligence as compared to the mass. Hence, in secondary mathematics, I wish intelligent students to advance in mathematical content and applications as fast and efficiently as possible, with full appreciation of any auxiliary cultural developments which can be attained. In this use of the word *cultural* I do not refer merely to the important intangible objectives such as acquaintance with the logical beauty of mathematics and its place as a method of thought. I would also imply that a useful cultural advance has occurred, for instance, if an intelligent student, regardless of his collegiate aspirations, has been

led through sufficient algebra so that he can finally study and appreciate the theory of pensions and life insurance—not merely the simple and often concealing arithmetic of such fields as presented by courses in pure arithmetic. On the other hand, in the case of the mass of the pupils, I accept for secondary mathematics a responsibility for extending their mathematical appreciation of their environment as far as is possible with their abilities. As a fundamental view, I reject the assumption sometimes made that classical secondary mathematics in modern forms has no educational significance for intelligent students unless they intend to enter college. With this introduction, I make the following suggestions for the field of secondary mathematics.

I. Students entering grade nine should be divided into two groups on the basis of their intelligence and previous achievement in mathematics, and without consideration for their present inaccurate estimates about the possibility of future collegiate careers. (Perhaps two thirds or one half of the students would be specified as a group L of lower ability and the remainder as a group S of superior type.)

II. Group L should be given a socialized course in mathematics in grade nine on a low technical level suited to the group.

III. Group S in grade nine should be encouraged to enter upon a three-year or a four-year mathematical program focused on advancement in technique, modernized by the inclusion of interesting applications whenever they can be efficiently presented, and including near the end—not starting with—a substantial course in applied mathematics based upon high school algebra.

IV. In grade ten, students previously located in group L who showed unexpected ability in grade nine should be encouraged to enter the ninth grade course provided for group S. In grade nine, students improperly located in the course for group S should be changed as quickly as possible to the course for group L.

V. In grades eleven and twelve, all superior students should be urged to consider the collegiate efficiency which might result from taking additional mathematics and to act as if a future college career were possible, in the hope[14] that some good fairy or an intelligent government might later provide college opportunities for those intelligent citizens who are without ample finances.

The preceding suggestions may seem impractical for the small high school on account of the difficulty of offering two courses in ninth grade mathematics. It might appear at first that the following suggestions were more appropriate in such a case.

A. All students, without differentiation, should take a socialized course in mathematics in the ninth grade.

B. Classical courses in mathematics, starting in grade ten, should be offered to students of suitable ability.

In my opinion, the primary weakness of (A) and (B) is the lack of differentiation in grade nine between groups L and S. The attempt to formulate the ninth grade course under (A) might lead to a final unfortunate choice, too difficult for group L and both boring and inefficient in the case of group S. If we presume that in each year the small high school will offer an essentially non-algebraic course for grade nine and also a first course in algebra, perhaps thought of primarily for grade ten, no apparent evil could arise if the intelligent students were allowed to omit the ninth grade course. Enthusiasts for the earliest possible inoculation of students with so-called socialized mathematics might claim that the specified ninth grade course would be too important to omit, but I reject this view as short sighted and dangerous. In fact, from my own acquaintance with and deep interest in the applications of algebra and arithmetic to common (but perhaps not *every-*

[14] This hope has been brought reasonably close to fulfillment by the federal aid dispensed to college students in recent years.

day) experience, I have concluded that the intelligent student gains greatly from delaying his principal contacts with many of these applications until the powerful methods of algebra are at his disposal. An early, unnatural, and incomplete approach to the applications mainly through the aid of mere arithmetic is likely to give a false impression of knowledge which is harmful.

Finally, then, for the small high school I advise a simple revision of my original plan rather than the method of (A) and (B). I recommend that, in the division of students into groups L and S, only those for whom strong evidence is available should be placed in group S, to be given, let us say, algebra in grade nine. Then, in grade ten, the high school should expect that many students who were classified originally in group L should be encouraged to take algebra. This would make the first course in algebra primarily a tenth grade course for students who have proved their ability in grade nine but, also, in the algebra course we would find a reasonable number of clearly qualified students currently in grade nine. Beyond the first course in algebra, we might hope that, even in the smallest high schools, individualized instruction would make possible the offering of additional mathematics to the limit of the qualifications of the students.

The preceding curricular suggestions lead me finally to a personal formulation of college entrance requirements in mathematics which do not conflict with the secondary program. I believe that the minimum efficiency level for entrance to a general four-year college curriculum should be two years of secondary mathematics, exclusive of any socialized course of non-algebraic type offered in grade nine. Along with this minimum *requirement*, I would advise the college to *recommend* in addition at least a semester course in advanced high school algebra. For a technical college, I would extend the minimum as far as possible under the limitations of the school's environment. In any junior college which is essentially an off-campus section of some four-year college, I would take the viewpoint announced previously for a four-year curriculum. For some junior colleges with limited two-year objectives, not associated with later college curricula, I can visualize the desirability of omitting explicit mathematical entrance requirements. However, I hope that in the development of such schools we may find an increasing number which at least *recommend* the presentation of mathematics for entrance so that the associated college curricula will not be prone to avoid natural mathematical viewpoints.

6. *Summary.* In this paper, the opinion was advanced that existing evidence does *not* prove the statement that college entrance requirements in mathematics are not valid. In connection with current research which presumes to justify the statement, the following main objections and inferences were made: (1) simple correlation technique is not suitable for measuring the effects of quantity of entrance mathematics; (2) conclusions are not worthy of weight if the achievement of a student group is studied without considering the effects of increasing mathematical homogeneity and artificial selection of course programs following an entrance deficiency in mathematics; (3) the typical statistical test of the validity of entrance requirements is fitted mainly to justify them in relation to existing course prerequisites and college standards, or to prove that the requirements should not be raised, rather than to prove that they should be lowered. It was suggested that, aside from possible cultural reasons, mathematical entrance requirements may be justified as a basis for providing a student body fitted to satisfy necessary prerequisites for college work suited to the aims of the college. Then, a program for secondary mathematics was proposed, independent of collegiate connections, with insistence on the necessity for two paths of development starting in grade nine.

Out-of-School Arithmetic of Sixth Grade Children

By NICHOLAS MOSELEY
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IN DECEMBER and January, 1937–1938, three groups in Grade VI of the Meriden, Connecticut, Public Schools kept "Arithmetic Diaries." Members of each group recorded day by day how they used arithmetic outside of school. An analysis of the results is given below, but almost more interesting than the tabulations of the actual arithmetic used are the side-lights on the life of many of the children—the time they get up, the time they go to bed, which ones have chores to do, what their allowances are (0–50¢ a week), what the families are buying from the store, what purchasing contests they are in, the games the children play, their reactions to winning and losing. The prize perhaps goes, pathetically, to the child who said, "I used my arithmetic. I went to grandfather's funeral. I counted the cars. There were nine cars." Or "I went to the store to pay a bill of $5.37. I paid the clerk $2.00 on the bill. How much left on the bill at the store. $3.37 was left." And "My uncle is paid $50 a month. He asked me how much that was a week and I figured it for him." The diaries make as fascinating reading as the Lynds' *Middletown*.

The most important transaction is making purchases and receiving change at stores and at the movies. Generally it is not clear whether or not the child calculated the change he was to receive or merely followed the adult habit of pocketing it without question. Only two reported the discovery of mistakes: one child was given a nickel too much and returned it; another was short-changed a nickel and had to ask the manager before he could have the mistake corrected. Eleven times children reported multiplying the cost of an item by the number they were to buy to find the sum due. The item was usually stamps. The sums involved vary from ½ cent (for stamps) to over a dollar, but the most frequent amounts are 1¢, 5¢, 10¢, 25¢.

Counting actually exceeds the use of money, but most of it is very simple. Sixth grade children seem to love to count, and they report tallies of many different things—cars at a funeral, freight cars in a train, pavement blocks on the way to school, Christmas trees in windows, and Massachusetts license plates. Counting utensils to set the table for the family explains most of the thirty-one cases of counting listed under chores.

Addition and subtraction were most frequently used to calculate the number of pages in a book already read or remaining to be read. They were also used in keeping the scores of games. Twelve boys used addition or subtraction to calculate the number of marbles they had won but only two reported losses.

The uses of division and of fractions were so few that it is possible to report the actual occasion. Use of division was reported three times—once to calculate a weekly from a monthly wage ($50 \div 4$), once to find the middle of a book ($200 \div 2$) once to find how long it took to earn 1¢ when a boy was paid 5¢ for 15 minutes ($15 \div 5$). Use of fractions was reported six times (excluding the purchase of $1\frac{1}{2}$¢ stamps to send Christmas cards, recorded under "store-change"): once to measure $8\frac{1}{2}$ feet, once to give ½ teaspoonful of medicine, twice in making ½ of a recipe, once in calculating profits on a magazine agency ($1\frac{1}{2}$¢ × 5 sales), once, perhaps a case of division, as follows, "I was reading about the *Queen Mary* and found out that it is 1018 feet long. I wanted to know what part of a mile, and figured out and found that it is ⅕ of a mile and 190 feet left over."

An examination of the tabulation shows that the out-of-school uses of arithmetic

SUMMARY OF OUT-OF-SCHOOL USES OF ARITHMETIC[2]

Reported for One Week by 91 Sixth Grade Children in the Classes of Eilene Fitzgerald, Stephanie Balasa and Florence Garrity, in the Meriden, Connecticut, Public Schools

Operation	OCCASION				
	Savings and Allowances	Store	Curiosity and Games	Chores	Time
Use of money	—	142	—	—	—
Counting	24	—	96	31	52
Subtraction	7	—	29	11	—
Addition	10	—	21	4	—
Multiplication	6	11	2	3	—
Measuring	—	—	13	2	—
Division	—	—	2	1	—
Fractions	—	—	3	3	—
Playing store					3
Miscellaneous (15 activities)					11

[2] A process used by each child on an average of once a day would produce 450 occurrences. Many diaries reported day after day "No Arithmetic" and it is obvious from the table that most children use no process except "counting change" and "counting for fun."

by sixth grade children differ very little from these reported by Nila Blanton Smith for first grade children.[1] One is forced to wonder what a similar study of adults would show. In any event it is clear that if the children are to put arithmetic to the practical use which many think is an essential to understanding and therefore to sound learning, the actual experiences must be provided *within the school room.*

[1] Nila Blanton Smith (*Elementary School Journal*, XXIV, 621–626, April, 1924, "An Investigation of the Uses of Arithmetic in the Out-of-School Life of First Grade Children") reports:

ACTIVITY	PER CENT
Transactions carried on in stores	30
Games involving counting	18
Reading Roman numerals on the clock	14
Reading Arabic numerals in finding pages in books	13
Dividing food with playmates and pets (fractions)	6
Depositing money in and withdrawing money from toy banks	5

An Arithmetic Problem

HERE IS an arithmetic problem that seems to interest everyone who tries to "work" it. It works; but *why* it works is something you will have to figure out for yourself. Ask your "victim" to write down his age; then multiply it by 2. Now, have him add 5 and multiply the result by 50. Then ask him to add the amount of loose change in his pocket (must be less than $1.00). From that result, subtract 365 then add 115. The answer will be a four-figure number and the two figures on the left should show his age and the other two figures, the amount of loose change in his pocket.—From *The Kalends* of Waverly Press. Vol. 17, No. 1, page 4.

On to Williamsburg!

SEE page 338 of the November issue of *The Mathematics Teacher* for the program of the Fifth December Meeting of The National Council of Teachers of Mathematics held jointly with the Mathematical Association of America and The American Association for the Advancement of Science this year at Williamsburg, Va., December 29 and 30.

Mathematics in a Program of Progressive Education*

By JOSEPH JABLONOWER
Board of Examiners, New York, N. Y.

It is probably not necessary, but since it may prove prudent to do so, I want, at the outset, to treat of the senses in which the term "progressive school" may be used, and to indicate the way in which I use it in the present brief discussion. I shall want next to indicate the manner in which the progressive school, as I define it, assumes the obligation to make certain investigations in ways of making the work in mathematics more significant to students and their communities. Finally, I shall make mention merely, since time allows no more than mention, of some of the ways in which schools have sought to meet this obligation.

I

I should prefer, if possible, to avoid altogether the use of the term "progressive," for it has become too parochial in character to have the genuine referent for which it was originally devised. But taking the situation as we find it, it is the next best thing to consider the senses in which the term is used, and to select from among these senses that one sense or that set of senses which will serve our purpose best.

First, then, in respect to the matter of discipline, progressive school may mean one that is utterly lacking in discipline or one that recognizes disciplines that are more fundamental in character building than are the spurious tricks and devices of reward and punishment to which the Ichabod Crane type of school master had to resort in order to keep robust children bearable. In the sense of recognizing discipline as necessary and useful, but a discipline that has self-direction and self-mastery as a goal, most teachers would be willing to be classed as progressive.

Second, in respect to the matter of logical organization and rigor of content, those who have misgivings concerning some of the trends called progressive, see in them a tendency to discard logic and logical sequence. At their best, however, progressive teachers, be it in the field of mathematics or any other field or area, see more than one pattern following from an effort at logical organization. There *are* choices available: a logical pattern that is serviceable in one setting and with one group of children may be utterly useless and hence, in a most fundamental sense, illogical for another group of pupils in another situation. For situations are themselves aspects of the logic of material. Logicality does not exist in a vacuum. The order worked out by a John Perry or a T. P. Nunn is no less logical, per se, than the order worked out by a Euclid. In respect to the purpose which they intended their material to serve, their content and arrangement were more logical than the traditional content and arrangement which they found less useful.

Third, in respect to rigor, progressive teachers are sometimes thought, by the critical, and sometimes properly so thought, to be soft, flabby. "Soft pedagogy" is the name given by the unsympathetic to the product of efforts of teachers in these directions. Not long ago, Professor Bell, in an article in the *Mathematical Monthly*, called "What Price Rigor?" directed our attention to the fact that rigor must be tempered to the learning lamb. Each stage of maturation in mathematics, as in other areas, has its appropriate degree of rigor. Progressive teachers have learned, in their work, thus to temper the rigor.

In these respects, then, of discipline, logical organization, rigor, taken at their

* Paper read at the summer meeting of the National Council of Teachers of Mathematics at Columbia University on June 27, 1938.

worst, the teachers and schools dubbed progressive seem lacking and neglectful of their duty to the pupils. Taken at their best, teachers and schools, whether or no they are considered progressive, are indeed exploring ways of enriching concepts and improving practice, experimentally, tentatively, yet adventurously, instead of being content to apply pedagogical formulae that are now devoid of content, whatever their pertinence at the time and under conditions in which they were first evolved.

In this latter and better sense in which I wish to use the term, progressive teachers and progressive practices are not limited to any one school or group of schools, public or private. No school or group of schools is uniformly progressive in all its aspects. Some of the most barbarous practices are observable in some of the schools most "notoriously" progressive. I cite one instance. In a school within a radius of 200 miles from New York, a leading progressive school, the visitor may see posted in every classroom a periodical pillory which takes this form: Classes are ranked in the order of progress made by them during the preceding marking period. The bulletin points out which classes have lost places in rank and, in the description of the causes of loss of places, the pupils responsible for them are easily identifiable by the detailed description of their lapses.

On the other hand, in schools which make no boast of being progressive or otherwise startling, one can observe in operation some of the most significant exploratory work in subject matter and in school organization. To stick to our own field, one need only mention, in passing, the work which has been done and is now being done, in this direction, by some of the members of this panel.

Whether, therefore, the schools are called progressive or call themselves progressive, or whether the schools are not troubling themselves at all about the label which they may claim or which is attached to them, it is the problems to which they address themselves and the ways in which they attack them that will determine for us their significance and their right to authority.

II

What are some of these problems?

First: a study must be made of the needs of adolescents in various relationships in which they find themselves: namely, individual growth and development, immediate family, social civic relationships, and economic relationship. Teachers of mathematics have their part in the field of general education no less and probably no more than teachers of English, foreign languages, the arts, and other sciences. All teachers are concerned with the genuine needs of their students and have as part of their province, therefore, consideration of these studies which give them light in respect to those needs. The work of the Commission on Human Relations and that of the Adolescent Study (under the auspices of the Progressive Education Association) are among the materials which will serve them to this end.

The felt or expressed needs of students are necessary considerations, but they are not sufficient. In addition, teachers unavoidably face the responsibility of anticipating some of these needs. It is the insufficiency of sensed needs as a guide that prompted Professor Boyd H. Bode to utter his word or his several words of admonition in his more recent book, *Education at the Crossroads*. In this book he points out the needs of a democratic society which must be taken into account. We must leave at this point the very interesting question as to whether there is a necessary conflict between the two types of need.

The discussion at this point may seem very remote from the needs of the classroom teacher for guidance and direction in his day-to-day task. I like to think this is not the case. In the report "Mathematics in General Education" published by

the Commission on Secondary School Curriculum of the Progressive Education Association, are considered some of the general propositions which I have just laid down. In this same report is given, also, an indication of ways in which the field of mathematics can be levied on for service in the areas of the relationships. In a collection of materials prepared by a summer workshop which was operated by teachers under these same auspices, are given samples of comprehensive units of work in mathematics that were evolved in response to specific questions that adolescents might ask themselves or that they often address to their parents or other adult friends. The results of such efforts, if you examine them, may strike some of you as trivial or, at best, confused and disorganized. Of some of these materials that is, indeed, a correct characterization. Some, however, are indications at least of richer possibilities for mathematics than are dreamt of by many students whom the traditional materials continue to doom to failure or disappointment.

Obviously more immediately and specifically pertinent to our immediate tasks as teachers of mathematics are the efforts at integration, integration being of two kinds: the first, an integration of the parts of mathematical field among themselves, of which the work of T. P. Nunn is the most conspicuous example; the second, an integration of mathematics with other areas, of which John Perry's work is the pioneering and outstanding instance. Schools and individuals are many in our own country that have endeavored to explore the possibilities. The obligation to explore further is being thrust upon even the unwilling among us, for the College Entrance Examination Board, nationally, and the Board of Regents, in New York, are withdrawing in increasing degree the many specific prescriptions which have served to guide those of us who needed guidance and have furnished alibis to those of us who sought alibis.

The uncharted freedom may frighten or tire us. It may, instead, be made to serve as a challenge to courageous enterprise and an inspiration to dedicated living. The challenge is to recast our materials so that we may retain whatever is in them of sound and rigorous and consistent experience and, yet, to make them more nearly pertinent to the lives of the young people whom they are to serve. It may serve to inspire us to more thorough and more profound scholarship so that we may the better explore with our students the rich interrelations of our subject with the sciences and the arts that are the study and concern of mankind. The best, in the teaching of mathematics, is yet to be.

Education in Depression

UNDOUBTEDLY in the hysteria of inflation the schools, like the colleges and universities, did some things that they can now do without. But the things that communities propose to do to them in the hysteria of economy far surpass the wildest aberrations of bull-market days. The plain fact is that the schools are under attack because it is easier to get money from them than it is to correct the fundamental iniquities and antiquities of local government. Only a people that had no conception of the place of education in its national life could contemplate the ruin of the next generation as the best remedy for governmental insolvency. —President Hutchins, University of Chicago.

The Relation of Reading Comprehension and Efficient Methods of Study to Skill in Solving Algebraic Problems

By Isaac L. Stright
High School, Freedom, Pennsylvania

This is the report of an investigation to determine the effect specific training in reading and efficient methods of study has upon a ninth grade student's reading ability and his skill in solving algebraic problems. The purpose of this investigation was to answer the following questions: Is there a definite relationship between a student's skill in solving algebraic problems and his ability to read with comprehension? Will pressure upon a student and guidance which forces him to be conscious of his reading mechanics have any effect on his reading comprehension? Will it carry over into his ability to solve algebraic problems? Is it important to stress functional terminology in the teaching of algebra?

Sources of Data. The subjects of this investigation were the Freshmen of Freedom High School, Freedom, Pennsylvania, in the year 1936–37. Data were collected from the Iowa Silent Reading Test, Form A; the Henmon-Nelson Test of Mental Ability, Form A; the Cooperative Algebra Test, Elementary Algebra Through Quadratics, Form 1936. The "Students' Guide to Efficient Reading" by Luella C. Pressey of Ohio State University and reading material gathered from magazines and books were used extensively.

Procedure. The Parallel Group Method[1] of Research was used in this investigation. This particular Freshmen Class, seventy in number, took ninth grade algebra from the same instructor, the writer. The class was divided into two groups, which will be referred to as Group A and Group B. The two groups were evenly divided as to size. No particular factor influenced the grouping of this class. Group A was used as the experimental group and Group B became the control group. At the beginning of the school year the Iowa Silent Reading Test, Form A, was administered to both groups. The results[2] of this test showed a difference of .92 between the mean scores of the two groups in favor of Group B. This difference falls within the probable error of the test and has, therefore, little significance.

The Henmon-Nelson Test of Mental Ability, Form A, which was administered in January, favored Group A with a difference of .42 between the mean scores. The probable error of this test is 3. The difference must be greater than the probable error before any significance can be attached to it.

The algebra instructor had Group A for an activity hour once a week. During the first semester this hour was spent each week in studying "The Students' Guide to Efficient Reading." The students were also given material on efficient study habits taken from "Educational Psychology" by A. M. Jordan.[3] This material was taught as a subject in itself with class recitation, drill and tests. The pupils were not only taught how to read, but also how to study and how to get the most out of their reading efforts.

Throughout the second semester of the school year this hour was spent each week in reading. Each student was permitted to read from magazines and books along his particular interest. They were permitted to bring books (fiction) from the school library or to read from magazines, some of which were: *The Reader's Digest, Cur-*

[1] *Educational Psychology*, A. M. Jordan.

[2] See Table I.

[3] *Educational Psyychology*, A. M. Jordan, Chapter VI.

rent Events, The Literary Digest, Popular Mechanics, Field and Stream, Outdoor Life, and *National Sportsman.* The students were encouraged to read material which had literary value. The emphasis, however, was not on what to read but how to read.

The instructor was constantly attempting to watch the mechanics of the students' reading. Several students were found to be "lip-readers." Guidance was placed upon them in an effort to overcome this hindrance. Student 28 was greatly handicapped by this fault. It is interesting to note his reading score increased from 64½ in September to 88 in May or from a grade level of 8.3 to one of 10.6. Student 15 seemed to have great difficulty in comprehending his reading material. After careful analysis, his difficulty seemed to be failure to hit a new line accurately. His score increased from 58 to 87 or from a grade level of 8.0 to one of 10.5 during the school year. These examples are typical cases of the procedure used upon the students in the experimental group.

Groups A and B both used the same algebra text and contacted the same materials in class throughout the year. However, when group A worked statement problems, the students were urged to be careful in their reading analysis of the problems and reminded of the facts which had been studied during the activity hour.

At the end of the school year the Cooperative Algebra Test, Elementary Algebra Through Quadratics, Form 1936, was given both groups. The results are shown in Table I.

In the latter part of May the Iowa Silent Reading Test, Form A, was again given to both groups. The results are shown in Tables.

TABLE I

Mean Scores and Standard Deviations (σ) of Iowa Silent Reading Test, Form A (total comprehension); Henmon-Nelson Test of Mental Ability, Form A; and Cooperative Algebra Test, Elementary Algebra through Quadratics, Form 1936.

	Reading Sept. '36		Reading May '37		I.Q. Jan. '37		Algebra May '37	
	Mean	σ	Mean	σ	Mean	σ	Mean	σ
Group A	77.08	31.3	107.86	32.1	107.42	11.7	26.63	13.45
Group B	78	28.2	89.3	31.04	107	10.05	18.76	5.08

Results:

The results show little difference in the mean scores of the reading tests administered in September. However, in the May test the actual difference between the mean scores is 18.56. If this difference between the mean scores is significant, one should know how reliable the obtained difference is or what its probable divergence is from the true difference which one should get if he should subtact the true average of Group B from the true average of Group A. Otherwise, if he compared the averages of other groups selected in a similar manner, he might eliminate or reverse the difference found. The formula[4] for calculating the reliability of an obtained difference between two means is:

$$\sigma_{(\text{diff})} = \sqrt{\sigma_{(\text{Av. A})}^2 + \sigma_{(\text{Av. B})}^2}$$

in which $\sigma_{(\text{Av. A})}$ is the standard error of the obtained average of Group A, and $\sigma_{(\text{Av.B})}$ is the standard error of the obtained average of Group B, and $\sigma_{(\text{diff})}$ is the standard error of the difference between the two averages. Thus to find the reliability between the two averages, one must know the reliability of the averages themselves.

The formula for the reliability of the average is[5]

[4] *Statistics in Psychology and Education,* Henry E. Garrett, p. 129.

[5] *Ibid.,* p. 121.

$$\sigma_{(Av.)} = \sigma_{(dis)}/\sqrt{N}$$

in which $\sigma_{(dis)}$ is the standard deviation of the distribution. N is the number of cases in the group. The standard deviations for the distribution scores of the groups were found by the usual procedure:

$$\sigma_{(Av.\ A)} = \frac{32.1}{\sqrt{29}} = 5.959$$

$$\sigma_{(Av.\ B)} = \frac{31.04}{\sqrt{33}} = 5.403$$

$$\therefore \quad \sigma_{(diff)} = 8.04$$

An obtained difference is interpreted in terms of its standard error in exactly the same way in which an obtained average is interpreted in terms of its standard error. Thus, we may say that the chances are 68 to 100 that the actual difference of 18.56 does not diverge from the true difference by more than ± 8.04; and that the chances are 99 to 100 that 18.56 does not differ from the true difference by more than $3 \times \pm 8.04$ or by more than ± 24.14.

One may be certain that the true difference between the averages of Groups A and B lies within the limits of 18.5 ± 24.12 or between -5.62 and $+42.62$. Since the lower limit of this range is negative there is at least some chance that the true difference is less than zero—that the average of Group B will sometimes be higher than that of Group A.

Now to determine the chances that the true difference between Group A and B is greater than zero, we divide 18.56 which is the distance of the mean difference from zero difference, by 8.04 the σ of the difference of the distribution. This tells how far the zero difference is below the mean in σ terms, $\frac{18.56}{8.04} = 2.31\sigma$ and from a table[6] of fractional parts of the total area taken as 10,000 under the normal probability curve, we find that in the normal curve 4896 cases in 10,000 lie between the mean and -2.31σ. Adding in the 5000 cases above the mean and translating cases over into chances, it is clear that the chances are 9,896 in 10,000 that the true difference between the averages of Group A and Group B is greater than zero. We may be practically certain, therefore, when we compare Groups A and B on the combined scale, that 98 times in 100 the difference between the average scores will be in favor of Group A. This answers the question, "What are the chances of a true difference greater than zero between Group A and B?"

The obtained difference in the mean scores of Group A and B in the algebra tests was 7.87 (26.63 − 19.76). This difference was analyzed by a process similar to that used in the analysis of the reading comprehension scores. It is certain that the true difference between the average of Group A and Group B lies within 7.87 ± 7.385, or between .485 and 15.255 for every 99 cases in 100.

TABLE II

Analysis of Sub-parts of the Iowa Silent Reading Test, Form A

	Group A		Group B	
	Sept. '36 Score	May '37 Score	Sept. '36 Score	May '37 Score
Paragraph Meaning	19.0	30.0	18.8	23.7
Word Meaning	26.3	33.88	25.8	29.8
Paragraph Organization	6.6	9.1	7.9	7.7
Sentence Meaning	12.6	17.0	14.8	15.0
Location of Information	12.5	17.8	11.0	12.4
Rate	23.3	26.0	21.0	21.5

The Iowa Silent Reading Test, Form A, is composed of specific tests on Paragraph

[6] *Ibid.*, p. 91.

TABLE III

Analysis of Sub-parts of the Iowa Silent Reading Test (May scores only)

	Paragraph Meaning	Word Meaning	Paragraph Organization	Sentence Meaning	Location of Information	Rate
Group A	30	33.5	9.1	17	17.8	26.0
Group B	23.3	29.4	7.7	15	13.4	21.5
Difference	6.7	4.1	1.4	2	4.4	4.5

Meaning, Word Meaning, Paragraph Organization, Sentence Meaning, Location of Information, and Rate.

These differences in mean scores were analyzed in a manner similar to the analysis of the total comprehension scores. Table IV shows the chances per 100 in which the differences will favor the experimental group.

TABLE IV

Analysis of Sub-parts of Iowa Silent Reading Test—Chances per 100 that the difference between the mean scores will favor the experimental group.

	Chances per 100
Paragraph Meaning	98
Word Meaning	98
Paragraph Organization	98
Sentence Meaning	93
Location of Information	99
Rate	98

TABLE V

Analysis of Sub-parts of Iowa Silent Reading Tests, Form A—Increase of mean scores from September, 1936 to May, 1937.

	Group A	Group B
Paragraph Meaning	11.0	4.9
Word Meaning	7.58	4.0
Paragraph Organization	2.5	.2
Sentence Meaning	4.4	.2
Location of Information	5.3	2.0
Total Comprehension	30.78	11.3
Rate	2.7	.5

Summary of Findings. The Iowa Silent Tests which were administered to both the experimental and control groups in September of the school year showed that until then both groups had progressed equally as far as their reading ability was concerned. The Henmon-Nelson Test of Mental Ability, which was administered in January, showed that the groups were equally balanced as far as the Intelligence Quotient is concerned. The two groups were, thus, well paralleled.

Both groups studied the same algebra text with the class work taught in a similar manner. The only exception was stated, namely, when Group A studied statement problems, the students were reminded to use care in their reading analysis and to apply the information they had learned during the activity hour. It would seem, then, if things were equal the groups should have made equal progress relative to their reading grade and their skill in solving algebraic problems. But the test results in May show the following:

1. The experimental group which received the specific training in reading, advanced from an average score in reading comprehension of 77.08 to 107.86, an increase of 30.78 while the control group progressed from 78 to 89.3 an increase of only 11.3. In other words the experimental group increased from a reading grade level of 9.5 to 11.8 while the control group increased from a reading grade level of 9.6 to only 10.6. The latter, of course, should be the normal development as revealed by the Iowa Silent Reading Test.
2. The average score on the Cooperative Algebra Test made by the experimental group was 26.63 while the mean score of the control group was only 18.76.
3. The difference between the mean scores on the total reading comprehension and the algebra tests were proved statistically to favor the experimental group 98 times in 100 among groups similarly selected.

4. The experimental group made greater progress in paragraph meaning, word meaning, paragraph organization, sentence meaning, location of information, and rate of reading than the control group as revealed by the mean scores of the sub-parts of the Iowa Silent Reading Test (Table III). These results will favor the experimental group 98, 98, 98, 93, 99, and 98 per 100 cases among groups selected in a similar manner (Table IV)

Interpretation and Inferences. A number of conclusions can be drawn from the results of this investigation.

First, it is obvious that a definite relation does exist between a student's ability to read with comprehension and his skill in solving algebraic problems. The Co-operative Algebra Test, Elementary Algebra Through Quadratics, Form 1936, is composed largely of statement problems. The experimental group in this investigation who received the special training in reading made a noteworthy gain over the control group in this test.

Second, a better knowledge of reading mechanics does increase a student's reading comprehension.

Third, this increase in reading comprehension does carry over into the student's ability to solve algebraic problems.

Fourth, Word meaning should be stressed in the teaching of algebra.

In the writer's opinion a number of inferences can also be made as a result of this investigation. First, if this increase in reading comprehension carries over to an increase in the student's ability to solve algebraic problems, it would seem likely that it would also carry over toward an increase in the ability to master other academic subjects. Of course, the experiment does not prove this inference. Further investigation is necessary.

Second, since the sight is the sense through which an individual accomplishes a large portion of his learning, would it not be advisable to include within the high school course of study a basic course in reading mechanics and comprehension?

Mathematical Georgie

Georgie studied 'rithmetic
He thought it was much fun,
And when the bell for classes rang
He answered on the run.

Georgie studied Algebra
With letters x and y.
He wrote his test with care and skill
I ne'er did hear him sigh.

Now Georgie studies Geometry
And thinks it quite a treat.
He talks of angles, squares, and lines
Every time we meet.

I try to change the subject
But it seems to come right back,
'Cause you simply can't get Georgie off,
His mathematics track.

—Louise Lyness, Sophomore, St. John's School, Ryan, Iowa

Can We Adapt Arithmetic Instruction to the Needs of all the Children?*

By J. Cayce Morrison
State Education Department, Albany, New York

A State Committee Faces the Question

A committee was assembled to determine the procedures that should guide them in preparing a State arithmetic syllabus for use in elementary schools. Early in their deliberations, some one asked whether it were possible for a State committee to prepare a syllabus that would actually help teachers to adapt arithmetic instruction to the needs of individual pupils. This question stimulated a healthy and not altogether comfortable discussion. It was apparent that all assembled were thinking primarily in terms of their grade placement of subject matter. For most, the only conception of adaptation to the individual differences among children was acceptance of the inevitable conclusion that some would learn more and some less from any exposure to which the entire group might be subjected.

However, the discussion led the committee to face the fact that children do vary widely in ability to profit from instruction in arithmetic, that added years of study only tend to increase the range of achievement, and that there are wide variations in need for arithmetic among individuals of relatively like-capacity, living in relatively like-situations or environment.

Facts from Studies in Variability

The committee reviewed briefly the evidence that has accumulated from the wide-spread use of standard achievement and intelligence tests. Two studies quoted here illustrate the evidence with which every one is or should be acquainted.

One of these studies, which included all the seven- and all the ten-year-olds enrolled in public schools of typical communities, showed that "the poorest ten-year-olds reached beginning second grade standards, while the best did better than the middle of the ninth grade. The poorest 10 per cent were below the middle of the second half of the third grade; the best 10 per cent reached seventh grade or better. To provide instruction for the middle 80 per cent of ten-year-olds, therefore, we need work which we have traditionally regarded as appropriate for 3A, 4B, 4A, 5B, 5A, 6B, and 6A, a range of seven half-years, while for the entire range of ten-year-olds, we need work representing the entire elementary and junior high school levels."[1]

This same study showed that in arithmetic computation seven-year-olds ranged in terms of grade placement from below the second grade to grade 4.5 and that ten-year-olds ranged from the beginning second grade level to the grade 9.8 level.[2]

Although ten-year-olds were found in many different grades the majority were in the fifth grade; but here again those ten-year-olds in the fifth grade with mental age ranging from 10 to 13 years inclusive had educational ages ranging from 9 to 15 years.[3]

In the light of such facts as the foregoing, it is not surprising that the author of this study of variability indicates that

[1] Ethel L. Cornell, "The Variability of Children of Different Ages and Its Relation to School Classification and Grouping," *University of the State of New York Bulletin No. 1101*, pp. 7–8.
[2] *Ibid.*, p. 95.
[3] *Ibid.*, p. 44.

* Paper read at the summer meeting of the National Council of Teachers of Mathematics held at Columbia University on June 27, 1938.

"the traditional concept of a grade as a level of difficulty or a level of attainment does not seem to be supported by practice."[4]

This conclusion is borne out by almost every study of the achievement of individuals in grade groups. In a recent survey of a city school system the Stanford Achievement Tests in arithmetic reasoning and computation were given to all pupils at the end of the fourth and sixth grades. There were about 800 pupils in each grade distributed through approximately 25 classes in 11 different schools. In terms of grade norms the poorest fourth grade class made a median score in arithmetic reasoning, of 3.0 as against 5.8 for the best class. In arithmetic computation the range from the poorest to the best was 3.6 to 5.2. At the sixth grade level the range from the poorest to the best on the reasoning test was from 4.6 to 10.1, and on the computation test, from 5.2 to 11.5. Here was a school system that represented the best in terms of a traditional grade organization and yet the range between the medians of the poorest and the best classes in arithmetic reasoning increased from the equivalent of 2.8 years at the end of the fourth grade to 5.5 years at the end of the sixth grade. For computation, the increase was from a range of 1.6 years at the end of the fourth grade to 6.3 years at the end of the sixth grade.[5]

Three Principles of Variability

In view of such facts, the Committee agreed that it was folly to assume that all children should be expected to meet a single standard of mastery of arithmetic at any particular grade level. Accepting this fact, the Committee attempted to formulate certain principles as a guide in developing a syllabus that would help teachers adapt instruction to the needs of individual children. Stated briefly, these criteria are (a) the amount of arithmetic needed by different children varies; (b) a considerable period of time may elapse between the child's first introduction to a mathematical concept and his mastery of computation involving that concept;—this period may be months or years and may vary widely for different children in the same class; (c) any individual's understanding of any mathematical concept is usually a matter of slow and intermittent growth.

In carrying these principles into effect the Committee worked along three lines new to syllabus construction in New York State.

Three Syllabus Adaptations to Individual Differences

First, it substituted a sequential organization for a grade organization of subject matter. The whole realm of mathematics for the eight-grade elementary school was divided into 9 categories, namely:

1. Counting, reading and writing numbers.
2. Addition and subtraction of whole numbers.
3. Multiplication and division of whole numbers.
4. Measurements.
5. Fractions.
6. Decimals, percentage, and related topics.
7. Geometry.
8. Algebra.
9. Problem development.

Each of these categories was developed in logical sequence; and the text of the syllabus was written in terms of the sequential development of each of these categories. In using the syllabus, if a teacher finds a pupil having a particular difficulty with a mathematical problem she has but to determine in which category that problem falls and then by turning to the treatment of the category she can very quickly determine the steps that the pupil should have mastered in leading

[4] *Ibid.*, p. 45.

[5] *Your Schools*, A Report of a Survey of the Public Schools of New Rochelle, N. Y., Board of Education, New Rochelle, 1936, p. 62.

up to the stage wherein his particular difficulty lies. This type of content organization should gradually convey to teachers the idea that pupils may work in the same class group on the same general topic but at many different levels of achievement.

A second departure embodied in this particular syllabus lies in its emphasis on the use of pupils' mathematical experiences as teaching material. To the child no problem is so acute, so vital, as that which has grown out of his experience or that has attracted his interest or curiosity. All pupils of a single age or grade group in the same school do not meet with the same problems. Therefore, to more effectively adjust mathematics instruction to the individual pupil, it is necessary to sensitize him to the mathematical elements of his daily experience, and for the teacher to detect his mathematical interests and curiosities as they arise. The Committee devoted a chapter to an analysis of the reports of teachers' use of the mathematical experiences of children; and the textual treatment of the entire syllabus is colored by this idea.

A third feature of the syllabus is its inclusion of a chapter on materials for the enrichment of mathematics instruction. After having developed the content which the committee believed should be made a part of the common heritage of all pupils who have the capacity to master it under good teaching, the committee was still aware that there were certain areas of mathematical experience which should be available, through the eight-grade elementary school, to those pupils who possess superior mathematical ability, or who having only ordinary ability may still develop some peculiarly driving interest that would lead them beyond the mathematical knowledge that should be made available to all children.

Among the materials outlined in this chapter of the syllabus were the historical development of number systems, development of units of measure, money and exchange, mathematical recreations, short cuts in mathematics, investments, thrift and saving, the metric system, square root, approximate area by scale drawing, comparing similar figures and objects, calculation of rate in installment buying, extensions of the study of graphs, extension of algebra, mathematics in a project or enterprise, foreign exchange. Other topics suggested were the cost of owning an automobile, methods of borrowing money, Boy Scout mathematics, school savings banks, how land is surveyed, and the use of the slide rule and simple calculating machines.

The Committee attempted to build a syllabus on the theory that good teaching may be highly individualized and that children of the same grade or school experience in the same class may work on materials of widely different levels of difficulty pertaining to the same topic or concept.

An Inquiry into Teacher Practice

More recently I made inquiry in five selected school systems to learn to what extent superior teachers are carrying into effect the recommendations of the syllabus with reference to adapting instruction to the varying needs of individual pupils.

Procedures for Determining the Needs of Individuals

Fundamental to any adaptation is the necessity of determining need. The methods used by teachers for determining need fall into six categories: (1) conversation with the individual pupils; (2) discussion with groups of pupils; (3) visiting the child's home; (4) the use of standardized, diagnostic tests; (5) the use of diagnostic tests prepared by the teacher or by a committee of teachers; (6) observing pupils in situations in which they use arithmetic. With one exception all schools and most teachers reported the use of standardized, diagnostic tests early in the school year. Some reported using them two or three times during the year.

Informal tests prepared by the teacher

or committee of teachers were used chiefly to supplement the standard test either in areas not covered by the latter or to supply a finer diagnosis than the standard test gave.

Use of individual conversation or the discussion group method appeared frequently in these reports. Visiting the child's home was mentioned by two teachers. Observing pupils in situations where they use arithmetic was mentioned occasionally.

Methods of Adapting Instruction to the Needs of Individuals

Several different methods of adapting instruction to the needs of individual pupils were described. These may be grouped under five different headings as follows:

(a) Postponement of formal arithmetic instruction to the third grade.

This procedure benefits primarily those pupils in kindergarten, first and second grades. In schools taking this step, special effort is made to provide many opportunities for pupils to think in terms of numbers. To those who have given little thought to the matter it is surprising how many natural opportunities there are for teaching arithmetic in the daily experience of pupils in the first and second grades. These opportunities run through all the various categories of arithmetic. They include the earliest concepts of geometry, fractions and measurement as well as the four fundamentals. There are opportunities for arithmetic in keeping the attendance of the class, distributing books and materials, numbering exercises on the blackboard; through reference to page numbers of books, keeping the records of games and outdoor play, and scores of other experiences in the daily living of primary children. Here the teacher first meets variations in the abilities of different pupils. Through informal discussions that arise chiefly from encouraging individuals to report to the teacher or the class their experiences which involve the use of numbers, the teacher contributes to the mathematical growth of individual pupils.

(b) Grouping pupils of similar abilities or with like disabilities.

There are two practices in grouping. One is the more conventional, more standardized procedure known as ability grouping where children have been tested and divided into two or three groups, either on the basis of their general mental ability or on the basis of their achievement in a diagnostic arithmetic test. Under this procedure such grouping possesses certain elements of inflexibility. The groups may exist for a semester, a school year, or even for a longer period of time. Such grouping usually assumes that all pupils in any one group need much the same kind and degree of instruction.

The second procedure is informal and flexible. The teacher following this procedure usually reports that 2, 3, 4 or possibly 5 pupils have demonstrated like need or disabilities, or like interests in some particular field requiring exceptional mathematical ability. Such groups are not fixed. An additional pupil may continue in a group for a few days or a few weeks as his need dictates. There may be a number of such groups at any one time. The emphasis is on the need of the individual rather than of the group.

(c) Special help to individuals.

Many teachers make opportunities to talk with each pupil individually to determine how the pupil thinks in mathematical terms. Some teachers find opportunity for such conversation at least once a week. The method is quite as applicable to the brilliant as to the slow pupil. It enables the teacher to discover the special ability or disability of any pupil, and consequently, is perhaps the most popular device or technique for effectively individualizing instruction in arithmetic, for it allows the teacher to help the pupil analyze his own thought processes.

As has been indicated the adaptation of instruction to the needs of individual pu-

pils depends upon careful diagnosis of need. Any group diagnosis invariably discloses disabilities among individuals. Regardless of how flexible the grouping plan may be there are always disabilities that require individual help. The teacher keeps a list of these individual disabilities. First, she helps the pupil to understand what his particular difficulty is; second, she helps him to find the proper solution to his difficulty; third, she provides him with practice materials to fix this solution or understanding in his mind; and fourth, at intervals she makes provision for review in order that the skill or understanding gained may not be lost.

(d) The use of the pupils' out-of-school experience.

Pupils of all grades in the elementary school have more mathematical experiences outside of school than most teachers realize. Some of these experiences are of interest only to the child concerned. Others are of interest to the entire class. A few typical illustrations taken from the reports of teachers follows:

"Two boys in the third grade this year have had paper routes. They are bringing in a record each week of the number of papers sold, and are computing the profits as well as comparing the sales from week to week.

"Four children are taking music lessons. A requirement of a specified number of practice hours per week is made by the instructor. Each pupil is recording the number of minutes spent at each practice period and is filing a daily as well as a weekly total.

"Two boys, one from the sixth grade and one from the seventh grade, constructed a rabbit hutch at home. Many of their measuring difficulties were met by being brought into the classroom where the teacher handled each in a way best suited to the occasion.

"A group of boys enlarged a scale drawing of a house from our textbook and put the house together. Numbers of pupils have used it when their measurements did not work out so well."

As one teacher observed, "things of this nature are brought out each term by the gifted and the 'not so gifted but interested,' so that it enriches the curriculum for them and provides teaching aids for me."

There are many general experiences which vary greatly for individuals and provide interesting materials for the entire group. The following quotations illustrate:

(a) "Banking day provides another opportunity for practical work with dollars and cents. Each child makes out his own banking slip, records his deposit and finds his balance.

(b) "After week-end trips, children bring to the group information as to the number of miles traveled. Numbers are computed to determine who has taken the longest trip, the difference in number of miles traveled by individuals, the distance between given points.

(c) "We especially discuss any work which pupils do and for which they are paid. Samples are: selling papers, pulling weeds, mowing lawns, etc. Very often this money is to be used for purchasing bicycles, so we are able to make many practical and interesting problems."

(d) "Our school recently held an exhibit on 'The Uses of Mathematics in Industries of the Niagara Frontier.' Many pupils talked with their fathers who were in industry and reported their findings to the class. Some brought materials to the exhibit, some made projects on the use of angles, squares, rectangles, etc., used in building."

(e) "A recent request came to me to aid in the formation of a 'math' club. Upon investigation, I found an interested little group which had been meeting and discussing mathematics and wanted help in 'making something definite'."

The following problems, typical of the experience of individuals and very practical for the pupil concerned, may or may not be practical problems for all pupils:

"Would it be cheaper for me to buy a dress in New York City at $4.98 or in R. at $6.00, if the round trip on the railroad costs $1.00, the city Sales Tax rate is 2% and I spend 10¢ on the subway?" B.A.W.

"If my uncle worked from 8:00 A.M. until noon and from 1:00 P.M. until 5:00 P.M. at $1.25 per hour, how much would he earn in a week of six days?" K.M.

"What profit does my father make on 500 gallons of gas which costs 13¢ per gallon and sells for 19½¢ per gallon?" C.K.

(e) Other methods of adapting instruction.

A few procedures or technics have been used by teachers for many years. Among these are having the brighter pupils coach those needing help; having the slower pupils return to a lower grade for certain types of instruction; and having slower pupils work at the blackboard where the teacher can observe quickly and easily their individual difficulties or needs.

(f) Materials used in adapting instruction to the needs of individual children.

Five different types of materials are in common use. First, the workbooks prepared to accompany the use of basal textbooks; second, miscellaneous workbooks for supplementary practice work; third, bulletins or practice materials prepared by local committees of teachers or sometimes by individual teachers; fourth, flash cards which are limited usually to the beginning grades; fifth, various forms of graphic reports and record-keeping which enable the pupil to keep an account of his need and his growth in mathematics understanding and computation.

One test to be made of the use of these materials lies in whether they are used merely as a refined form of busy work or whether they are used intelligently by the teacher to individualize instruction. If the material used is selected on the basis of adequate diagnosis, if its use is accompanied by analysis of pupils' need and ability through frequent conversation and class discussions, then these materials become an effective aid in adapting instruction to the needs of individuals.

Important Mathematics Meetings

SECRETARIES and publicity representatives of mathematics associations and clubs throughout the country render a great service by sending reports of meetings and activities for publication in THE MATHEMATICS TEACHER. This service benefits not merely the editorial staff of the TEACHER but also other clubs and teachers who want to share in the really original thinking and discussion that goes on in local groups.

Don't think that the absence of names of important leaders in the field of education or of mathematics teaching makes your program less significant or helpful to others. The contributions of active rank and file classroom teachers also determine trends in the teaching of mathematics. Often the knowledge that other teachers are concerned with certain problems heartens and encourages those faced with the same problems, and the interchange of opinion and possible solutions is of great value.

Whenever possible, it is desirable to have in advance announcements of large meetings which might attract additional attendance through the columns of the TEACHER. However, reports of meetings already held are also valuable because they contain results and conclusions of teacher group activities.

There are no formal specifications according to which these accounts should be written, except to include the answers to the newspaperman's questions of WHO WHAT, WHEN, WHERE, and sometimes WHY and HOW.

Have you paid your dues?

THE January issue of *The Mathematics Teacher* will be sent *only to those whose dues are paid.* The date of expiration of your subscription is stamped on the wrapper of your December issue.

Applying Geometric Methods of Thinking to Life Situations*

By Mrs. Elizabeth Loetzer Hall
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It is the purpose of this paper to deal with actual class room experiences in applying geometric methods of thinking to life situations and so I shall merely state briefly some of the considerations upon which our attempts have been based. I think we agree that geometry is the simplest and most convenient introduction to postulational thinking that has been devised, and that it offers the one procedure that promises valid conclusions on the basis of clearly formulated assumptions. There are those, however, who claim that the traditional place of mathematics in the curriculum is due to the "exploded doctrine of mental discipline" and that accordingly the alleged educational values of mathematics are largely a myth. Such opinions are obsolete in the light of the results obtained from the careful research work in the transfer of training of men like Lashley and Orata. The fact of transfer (of training) from one activity to related activities seems established. But the equally important consideration that in order to obtain this transfer we must teach for it, has not yet received due emphasis.

Another group of critics assert that we are concerned first of all with rational living, not with rational thinking. We claim that living can *not* be rational unless it is controlled by "understanding, insight, and self-discipline," and that, as Professor Dewey says—"If intelligence could be raised to the position of the controlling method of action, it would change social life to an extent not short of revolutionary."

More and more, teachers of mathematics are attempting to teach geometry so as to transfer postulational thinking to secure rational living. Many of them are doing splendid work with selected groups. But it is, of course, difficult to find the opportunity to break away from traditional procedure to any extent if pupils must pass a prescribed examination, and if the result of a teacher's work is judged by the number who successfully pass this examination. Therefore, in public schools the progress has been slow.

For some time we have been working with the idea of transfer in various types of geometry classes, but the results reported in this paper come from a group of pupils selected for their lack of ability to do the work in a regular geometry class. They were considered below average in intelligence, and many of them came from non-English speaking homes. The quotations I shall read are exactly as the pupils wrote them in the course of their daily class work.

The plan which I use requires that we make a careful approach to geometry by showing the need of proof. Civilization has become so complicated that no one is able to gain all his knowledge first hand. Each of us must rely largely on what he is told or on what he reads. Newspapers report the alleged events of the day and the alleged opinions of others. In all this mass of material, much is bound to be false, some to be true. In all cases we may either accept the assertions of others or we may assume a critical attitude and ask whether or not reported statements are true. The demand for proof is illustrated by the case of the person who buys a piece of property and requires the seller to furnish him with an abstract of title which proves that the seller has a right to the property and a right to sell it.

* Paper read at the Annual Meeting of the National Council of Teachers of Mathematics at Atlantic City, N. J., on February 26, 1938.

From the *need of proof* we go to *methods of drawing valid* conclusions. And here the teacher has in mind that postulational thinking possesses certain definite qualities, namely:

1. It starts with fundamental notions not defined.
2. It assumes a set of propositions.
3. It then defines terms which grow out of the undefined ones.
4. And finally it proceeds to proofs deductible from the undefined ones.

It follows, therefore, that any attempt at orderly cumulative thinking involves two major things:

1. Scrutinizing basic concepts and
2. Testing the correctness of every step of the reasoning.

Scrutinizing basic concepts implies that we uncover assumptions, that we test the validity of these assumptions and that we investigate the use of terms in the light of the definitions of these terms.

In order to bring about the development of these ideas we go to the experience of the pupil for illustrations before using geometric material. One of the sequences used this fall was introduced by the question, "What is the assumption back of your coming to school?" One boy replied, "I come to school on the assumption that education is necessary in a democracy." Then, of course, we were obliged to discuss the definition of education and of democracy. It happened that in the school assembly shortly before, we had had a speaker who described the present situation in Germany and in Italy so the class interest in these definitions was keen. The group brought out the idea that education meant different things in America and in Germany—in Germany it meant "preparing a boy to be of use to the state," while in America it means "preparing him to live a happy, useful life." Differences in definitions of democracy were developed also. This led us to see how the whole structure based on definitions changed with a change in the underlying definitions. In this particular instance it was easy to see how the entire life of a people was affected by its conception of education.

In connection with definitions we brought out the idea that a definition has its roots in the experiences of humanity and that it is an agreement which sums up these experiences.

Rules for games such as basketball or soccer and the definitions of terms used serve as excellent illustrations of the use of definitions and accepted propositions. The games used will be those suggested by pupils in the group. "Heads Up," a baseball picture shown in assembly gave us an illustration of change in rules. In the early days of baseball a man slid head first to a base. Now the rules require him to slide feet first. You will notice that the particular material used at any time is drawn from pupil suggestion and is retained only if the class is interested in it. However, the direction the discussion takes and the use to which the material is put are directed by the plan which the teacher must always have in mind.

Other applications of scrutinizing basic concepts can be made by using printed advertisements, radio advertising, and newspaper statements. A thrift poster displayed in our school lobby says, "You will need money to become a radio star. Save Every Banking Day." This made an excellent text for studying assumptions. We used also the advertisement for a popular brand of soap. This advertisement showed a young lady beseiged by telephone calls asking her for dates. "Sally's in a whirl these days—she's learned how to guard against cosmetic skin," it states and adds, "Use all the cosmetics you wish! I guard against cosmetic skin by removing make-up with X Toilet Soap." To the question, "What is the assumption behind this picture?" one boy wrote, "This advertisement implies that if you use X soap, you will become as beautiful as this person and have many dates. This is not true because other kinds of soap cannot do it for you, so how can

X soap?" Another said (in better form) "The company which was responsible for the advertisement made an attempt to sell its soap by creating in the reader's mind a false impression. The reader was supposed to assume that the use of this soap would make the reader beautiful and, as a result, open the door to popularity and happiness."

Pupils will give you their own illustrations. For example:

"The present business recession has come after a period of government regulation.

"Assumption—the government was responsible for this recession."

Scrutinizing basic concepts requires us to *test their validity* after recognizing them. So the next discussion deals with what constitutes authority. This will lead you to the use of the dictionary for the meaning of words, to the Constitution of the United States as the basis of government, to social customs and habits as the basis of social behavior, and to the axioms and postulates in geometry.

One study of this kind dealt with certain table manners—the use of napkin, knife, and fork. Why is it considered good social behavior to use them? We brought out the fact that their use is due to custom, that is, to an agreement which has been arrived at after a long period of time. Why have we reached this agreement? And here we discussed its reasonableness. Then some popular notions were discussed such as, "When in Rome, do as the Romans do." Are all such popular slogans true? Should we rely upon them? And we decided that many of these were arrived at by "hunch and hearsay" and that we do not want the world run by people who arrive at their opinions by this method.

Recently "The Buccaneer" was playing in our city and many of this group saw it. It happens that the January 10 issue of *Life* contained a review of this picture with the comment "For his annual epic, Cecil DeMille has again turned to United States history. From the opening scene, in which Dolly Madison flees from the White House with the Declaration of Independence (this is doubtful history), to the closing shot it is robust, exciting, grandiose." The following week, *Life* printed a letter from Mr. DeMille in which he said in part, " *Life* calls 'doubtful history' Dolly Madison's flight from the White House with the Declaration of Independence. The following is from *Memoirs and Letters of Dolly Madison* by L. B. Cutts:—'Hoping and fearing, Mrs. Madison lingered on at the President's house for Mr. Madison's return, until the British officers were actually at the threshold. She had secured the public papers and the Declaration of Independence, and was being hurried to the waiting carriage, when her eye was attracted by the valuable portrait of George Washington etc.'"

The editorial comment on this letter was,

" *Life* has no wish to hold an able movie producer too strictly accountable for his history. It feels, however, that Mr. DeMille was not properly suspicious of his sources.

" First: It is well known that Mrs. Madison saved the Washington portrait. But no first-rank historian, so far as *Life* knows, mentions the Declaration of Independence in connection with her; and the Cutts reference is oblique."

Several of the pupils had seen these copies of *Life* and the comments, so we had an interesting discussion on what constitutes authority in such a case. One boy asked whether *any* history book wasn't good enough authority? He wanted to know who was right. This brought up the question of original sources for historical material and the fact that writers often color their reports by their own interpretations and prejudices.

Another pupil wanted to know whether I didn't think we could be too critical. And here was the opportunity, made by the class itself, to develop the difference between a search for genuine authority and the kind of wrangling on problems of

the day, to which many of them are accustomed.

Elections—for whom to vote? "Some people vote for the best looking candidate," volunteered one. School elections entered the discussion and out of it all came the conclusion that when we really try to get at the truth or falsity of statements, or when we try to reach fair judgments, we use the methods of geometric thinking.

Immediately following such a discussion, we turn to a problem in geometry to see how that is reasoned out and thus keep our illustrations parallel.

The second requirement of orderly cumulative thinking is testing the correctness of every step. This means *checking an argument presented to you* or *developing one of your own*. That is, you may be required to follow, step by step, the proof of a theorem worked out in your geometry book, or you may have to prove an original. The first of these requires you to see if the statements made can be justified by the use of definitions, axioms, postulates, and theorems previously proved. You are merely following another's argument to see if he has made a mistake. The second requires you to make the argument yourself—to find your own way and also to be able to justify every one of your statements. As an illustration of the first a newspaper argument is used. Follow it through, ask what reason can or is given for each step, and upon what authority this reason is based. Some of Dorothy Thompson's articles are splendid for this purpose. One published in the *Times Union*, January 28, 1938 states as a proposition, "We are getting a unique form of government. I might call it government by press conference." She then goes on to prove her theorem giving reasons as she goes. In one place she says, "In his Wednesday column, Mr. David Lawrence gives some interesting figures which I have been unable so far to check. He says" . . . (giving figures from Mr. Lawrence's articles.) Then she adds, "If these figures are correct, then what the President is asking is just plain impossible." In connection with this statement the class brought out the idea that Miss Thompson must have considered Mr. Lawrence good authority or she would not have quoted his figures before checking them. They also said that they thought she was very fair in saying that she had not checked them, and that if Mr. Lawrence was wrong then Miss Thompson would also be wrong. Pupils brought articles with reasons underlined and discussed these from the standpoint of validity. When it comes to developing one's own argument a composite figure is useful. We take such a figure and starting with a certain hypothesis we try to discover as many resulting relations as possible, testing and checking each. This lets a pupil experiment, it requires him to sort and classify what he knows, to pick out what is relevant and reject what is not. This is a valuable, practical thing for the pupil. His problem in life is not always definitely stated—"given this—prove this or do that." Too often he has a given situation and he must get out of it what he can. Certain things which can be proved on his figure will be more significant than others in that they will lead to further discoveries, while others will not. So, in a life situation. Dr. Kilpatrick says, "The difficulty in instances of emotional maladjustment is not the absence of thinking but a poor quality or type of thinking. The discouraged pupil thinks of the mortification attending failures, dwells on it, and nurses it instead of asking himself, 'Now this has happened, what can I best do about it?' Control by mood spells maladjustment; control by intelligent study means healthy-mindedness."[1]

In this particular type of geometric exercise, pupils sometimes make wrong deductions; that is, they jump at unwarranted conclusions. Here the checking and proving will set them right. Before we had

[1] William H. Kilpatrick, *Remaking the Curriculum*.

reached this stage in our class work this fall, a boy asked me, "If we are learning geometry in order to teach us how to think, and we are given theorems to prove because it will train our minds to think as wisely in other matters, then why aren't we given theorems which are not true? I think this would help us because we hear and see things in life which are not true."

Surely it's a good thing to see what can happen and not always to be trying to justify a given happening. The driver of a car who anticipates possible accidents and thus avoids them illustrates this sort of thinking.

One class exercise used was the study of a figure with a specific hypothesis and conclusion.

Assignment I: (1) List all the statements you can find to be true about this figure.

(2) Out of these select and arrange in proper sequence the ones which will prove this particular conclusion.

(3) What other conclusions could be proved besides the one asked for?

II—(1) Make a list of the subjects you may choose from in making your next term's schedule.

(2) Pick out those you actually intend to take and give the reason why you have selected each one.

In the March 1938 number of the *Commentator* appeared an article by Albert W. Atwood in which he said, "We still live in a universe where choices have to be made, where selection is necessary if human beings are to get along together at all, and where if you choose one alternative you cannot by the same token have another. This homely truth is not only unpopular, but is looked upon as thoroughly antiquated. Most of the leaders of the day scornfully pooh-pooh such homely doctrine. Instead they talk about the abundant life and give the impression that if it were not for a few wicked capitalists, economic royalists, and princes of privilege we could all have everything we want. Indeed, any timid person in the audience who raises his hand to ask a plain, straightforward financial question is treated with pitying contempt. . . . It is a wonder that simple arithmetic is not banished from the public schools, so hateful are its precepts to what might be called the new thought of the day. To my way of thinking, however, the American people need nothing so much as to learn all over again that addition and subtraction are among the most nearly irrevocable forces in life."

This statement seems to me a challenge to us to accomplish in our teaching of mathematics the very thing we are talking about—the transfer of mathematical thinking to every phase of life.

The point about all this is that if the type of thinking which geometry employs is to be transferred to everyday affairs, we must help the pupil make that transfer. Can we do it? In reply to the question, "Has the geometry work taught you anything about how to think? Has it helped you?" a pupil who was repeating geometry after having failed in a regular class, replied:—

"A study of geometry makes one conscious of the existence of consistent, step by step, thinking. The task of proving lines end angles equal is a simple means of training the student, by practice, to do straight thinking, just as the coach trains the basketball player to prepare for the big game of the season by constant practice. Before the student of geometry can come to a conclusion he must go through the following steps:

1. He must present the facts in a logical order and explain each one of them.

2. His facts must be consistent.

3. He must accept the geometry book as his reliable authority. This procedure might well be applied to many important problems which confront us in our daily life. Too many students, however, look upon geometry as another hurdle which must be jumped in order to get a diploma. If geometry is properly taught it can become an invaluable instrument used to

broaden man's mind and thus prepare the way for greater achievements."

We can not hope that a pupil will or can make this application of deductive thinking to his life unaided. As Dr. Hedrich says, "Guidance, actual teaching, is required to assure the simplest possible carry-over of this type. We shall get very little "transfer" unless we make it a part of our business to *teach* it, every day and at every opportunity, in large matters, and in small numerical instances.—I think it is far more vital for us to teach the student how to transfer his training to different fields that it is to go through all the details of logical proofs."[2]

More and more teachers are coming to agree with Professor Hedrick, at least in theory, but they are hampered by the extent and detail of the geometric content required by the usual syllabii. Moreover, many teachers miss the goal by being unsystematic. They mention now and then some connection between the reasoning of geometry and a life situation, hoping that the child will continue to make other applications. Such a method is haphazard at best and many of our present attempts are just that!

The only significant manner in which to attack the problem is to be systematic. The teacher must know first of all the characteristics of postulational thinking which he wishes to transfer. He must see that these are understood thoroughly in connection with the teaching of geometry. Then he must find applications from the lives of the pupils concerned if he wishes his work to be meaningful. Pupils are no more interested in "learning to think" by the use of material which does not touch them personally than they are in the use of geometry as such—sometimes not as much.

Just as definitions have their roots in the experiences of humanity, so a child's thinking has its roots in his own experience. It is for this reason, I think that we are unsuccessful when we attempt to apply geometric thinking by the use of such illustrations as—

"1. All Chinese are yellow.

2. Wing Toy is Chinese.

If we agree to these two statements, what third statement are we forced to accept?"

An example of this type represents an isolated incident unconnected with the pupil's immediate experience. It has no past and no future—it is just an incident.

The whole structure of geometric applications and life applications must be interwoven. In fact, the whole structure of mathematics and life situations should be so treated. We can not develop in a child the ability to think mathematically in a year or in two years, neither can we expect to accomplish our aim by the use of one so-called subject. The structure should be unified—the work should be continuous and the time devoted to it adequate. The Joint Committee is now working on a program by means of which they hope to make the program of school mathematics continuous and united from the seventh grade through the twelfth.

We are the only nation which attempts to teach geometry in a year and our efforts are not being received with loud acclaim! Quite the contrary. We need more time if we are going to be able to transfer to our lives these most valuable lessons from geometry, if we are going to teach a pupil to "accept responsibility for thinking through his own experiences."

The number of required propositions might well be reduced—and a selection made which will constitute a consistent set smaller than we ordinarily use. After all, I am firmly convinced that every pupil who sees how geometric reason applies to everyday affairs will be grateful for the experience when the facts and the propositions of geometry have faded into the dim distance.

[2] E. R. Hedrick, THE MATHEMATICS TEACHER, February, 1937.

◆ THE ART OF TEACHING ◆

The Problem of Review

By M. Richard Dickter,
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The problem of forgetting, particularly where specific skills are involved, is always a discouraging one. One teaches a unit of work, and, unless the skills learned in this unit are used in the next unit, the students forget them. That is always a pity, and becomes more than that if the skills learned earlier in the term are needed later in connection with new work. It is necessary to review periodically, and certainly just before a previously learned skill is to be used again. The efficacy of these periodic reviews is likewise problematical. Let us say that, during the review, the student regains his lost skill, but it is soon forgotten again unless used. Moreover, when the course of study is a crowded one, as is usually the case, it is difficult to spare the time for these reviews.

The writer has devised a scheme whereby he uses the daily homework in the junior high school to overcome this problem of forgetting skills once learned. Each day the homework consists of a few examples of current work plus one example on each of the preceding units in which skills have been learned and should be maintained. Thus, when a unit is finished, it is not dropped, to be reviewed spasmodically, but one question on this unit is included in the homework each day. The next day the correct answers for the homework are given and any student who had an example wrong and cannot find his mistake is given a chance to ask questions about it. He is brought to see his mistake either by questions or by having a student who had the example in question correct put it on the board. And there are always eager students to do the examples on the board. Very little time is needed to straighten out these questions because the students, after a while, become so skilled in the operations involved through constant review that they either see their mistake at once or as soon as it is brought to their attention. Thus every day becomes review day and the students maintain a high degree of skill throughout the term.

It does not take the students long to reach the stage where they will ask questions when they cannot find their mistakes. They soon realize the helpful attitude of the teacher, the cooperative nature of this checking process and the benefit they derive from finding their mistakes. The students enjoy this daily checking process immensely. They wait for it eagerly and are very grateful when they are brought to see where they have made their mistake or see it for themselves.

It may be argued that the homework becomes too much as the number of units studied increases, particularly toward the end of the term. But that is not so. The course of study in any grade consists only of a half dozen or so major units in which specific skills are taught, so that by the end of the term the homework may consist of five or six review examples and a few examples on current work. Such homework is far from excessive. It takes the students only from ten minutes to a half hour at the most to do this homework, even during the latter part of the term. Of course, if the homework does tend to become excessive, it is always possible to

alternate, that is, to assign examples only on half of the previously learned units one day and on the other half the next day.

It may also be argued that the constant repetition would tend to make the homework monotonous to the students. But that is not so either. They soon realize the nature of this homework and its purpose. They take a keen delight in doing it because they know that thereby they are not only maintaining the skills they have learned but also developing them.

This system of homework works splendidly. Skills once learned are not forgotten. When a certain operation previously learned is needed for a new unit, it is not necessary to stop for a while to reestablish a fair degree of skill. For example, in one grade, square root had been taught at the beginning of the term and the Pythagorean Theorem at the end of the term. The students had maintained such a degree of skill in square root through having done square root in homework each day that when the Pythagorean Theorem was presented, they literally "ate up" the examples, as one student expressed it.

To be sure, this type of homework does mean more work for the teacher. Such homework cannot be assigned from a textbook. It involves more than telling the class: "Take examples 1 to 5 on page 275 of the test for homework for tomorrow." The teacher must plan the homework specially each day and write it out on the board for the students to copy during a certain few minutes of the period devoted to this purpose. A sensible procedure is to have the homework written out on the board at the beginning of the day, so that when the students enter the room they see it and copy it in their assignment books. The results, however, justify this additional effort on the part of the teacher.

LOGIC IN GEOMETRY

The Importance of Certain Concepts and Laws of Logic for the Study and Teaching of Geometry

By Nathan Lazar, Ph.D.

Are your students sharks at originals but still making hair-brained, erratic judgments outside of the classroom? Dr. Lazar tells teachers how to make the study of geometry real training in logical thinking. He offers a new solution to the old problem of transfer by showing specifically how to teach students to apply the methods of logical reasoning learned in the study of geometry to real life problems. Here are fresh answers to the challenge "What good is geometry?"

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EDITORIALS

A Mathematical Atmosphere

THERE are many people who feel that mathematics is a dark and mysterious subject devoid of all interest. To others it seems, at best, a rather drab affair, while to a rather significant number mathematics makes a decided appeal. Be that as it may, there is no reason why teachers of mathematics in the elementary and secondary schools, to say nothing of the colleges, should not do something to make their classrooms a little more appealing. If mathematics itself is dry to some pupils, the situation may be improved by having an interesting looking classroom and an inspiring teacher. Not all teachers are equally inspiring in all that they do, but they can, at least, make their classrooms more attractive than the majority are today. Many of these classrooms not only have no proper mathematical equipment such as rulers, protractors, squared boards for graphic work, and the like, but they have no pictures of any kind to relieve the monotony of the formality of the algebra or geometry which the pupils have to study.

A very excellent picture of the "Tree of Knowledge" in colors may now be had (prepaid) by sending twenty-five cents to the Museum of Science and Industry, Jackson Park, Chicago, Illinois. This picture can be framed for a very small amount and either covered with glass or shellac to preserve it indefinitely. A set of six pictures, each 8″ by 10″. depicting the episodes connected with the History of the Standard Units of Measurement may be had (prepaid) by writing to H. G. Ayre, Western State Teachers College, Macomb, Illinois. A set with glossy finish is $2, or a set beautifully hand-tinted in oils is $5. These pictures may be framed separately or in one long panel and they add life and beauty to the classroom. The Educational Service Department, Chevrolet Motor Division, General Motors Sales Corporation, General Motors Building, Detroit, Michigan, has printed a large poster suitable for classroom use on which are reproduced three illustrations which appeared in the May (1938) issue of *The Mathematics Teacher*. The illustration relates to the Mathematics of the Automobile. This large poster looks well in a natural color wood frame and will be sent free to any mathematics teacher as long as the supply lasts.

These and other pictures of famous mathematicians which the teacher can now secure from Scripta Mathematica, 610 West 139th Street, New York City, will add color and interest to any classroom. Of course, the personality and taste of the individual teacher will determine the kinds of pictures and other decorations to be used. The point to be made is that mathematics classrooms must be made more interesting and should reflect more of the atmosphere of mathematics.

W. D. R.

More Modern Mathematics

By this time it should be obvious that if mathematics is to serve fully the needs and interests of pupils today, a new type of textbook is necessary. This does not mean that there are no textbooks that contain material suitable for meeting modern needs. It does mean that most textbooks in mathematics are dominated by seventeenth and eighteenth century material.

Textbook writers, particularly in al-

gebra, used to say that they had to include much of the formal traditional material in algebra because that was what the teachers wanted. It is clear that there are still some teachers who prefer the old regime, but it is equally clear that a large number of teachers of algebra today are ready for a new deal. They realize that unless algebra is reorganized and the teaching of it improved, pupils will continue to drop out of the course. Again, authors in the past have been too prone to lay the blame for the traditional and formal mathematics that remains in their textbooks upon extra-mural examining bodies like the College Entrance Examination Board and the New York Regents system. But with completely reorganized syllabi in both of the above systems, this excuse for failure to improve textbooks should no longer be offered either by authors of textbooks or by the teachers who use them.

Again, the needed reform is not secured by writing new courses of study because teachers do not follow them closely. If someone were to ask, "What mathematics is taught today in the schools?", it would not be far from the truth to say, "Look in the textbooks and see." There are obvious exceptions to what has been said above, but the fact remains that we are going to fail in meeting the needs of large numbers of the pupils in the schools today unless a new set of textbooks designed to improve the present situation is forthcoming.

W.D.R.

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IN OTHER PERIODICALS

By NATHAN LAZAR
Alexander Hamilton High School, Brooklyn, New York

1. Blumberg, Henry, "What is Essential in Teaching Mathematics?" *National Mathematics Magazine*, 12: 393–402. May, 1938.

A few interesting analogies are pointed out between the skills and attitudes inherent in the competent playing of a musical instrument and those requisite for the teaching of mathematics.

2. Goodstein, R. L., "Geometry in Modern Dress." *The Mathematical Gazette*, 22: 217–224. July, 1938.

It is a commonplace of mathematics that in the axioms of Projective Geometry we may substitute any elements we please for the words "points," "lines" and "planes," provided only that the axioms be satisfied. Such a proposal is carried out by the author in a very entertaining, but highly instructive manner, by setting up the rules governing an imaginary "International Typewriting Agency." The analogue of Pascal's Theorem appears in a disguised but recognizable form.

A game of letter-board is also expounded with rules which cleverly conceal their geometric counterparts. Desargues' Theorem as well as Pascal's Theorem now appear in a new dress.

The purpose of the author is not only to provide many new puzzles and diversions "but also to throw some light on what may be called the foundations of geometry, for only by comparing the many forms in which the propositions of geometry may be expressed can we learn something of their real nature."

3. Keyser, Cassius Jackson, "A Mathematical Prodigy: History and Legend." *Scripta Mathematica*, 5: 83–94. April, 1938.

An address given at the Galois Institute of Mathematics, Long Island University, on Blaise Pascal.

4. Krueger, Raymond L., "Prehistoric Mathematics?" *School Science and Mathematics*, 38: 797–798. October, 1938.

A fanciful story about the two cave men Ab and Ug and the way they discovered the usefulness of symbols in general and of mathematical symbols in particular.

5. Miller, G. A., "Mathematical Myths." *National Mathematics Magazine*, 12: 388–392. May, 1938.

The reader is warned "that the popular recent writings of E. T. Bell tend to emphasize various mathematical myths instead of to reduce their number. . . . It might be said that the nature of the writings of E. T. Bell is such that one would naturally not expect accuracy as regards many questions relating to the history of mathematics, but the reader should realize that he is in danger of contributing toward the spreading of mathematical myths when he quotes from these writings without verifying the accuracy of statements contained therein."

The following are some of the mathematical myths that Professor Miller attempts to shatter:

1. That Pythagoras discovered the existence of irrational quantities.
2. That Napier's logarithms are our modern logarithms to the base e.
3. That John Speidell published tables of natural logarithms.
4. That Cardan plagiarized the well known solution of the cubic equation from Tartaglia.
5. That the ancient Egyptians knew the fact that the area of a hemisphere is equal to that of two great circles on the surface of the sphere, and that they therefore knew a theorem which has been credited to Archimedes and constitutes one of his most conspicuous mathematical contributions.
6. That mathematics is a divided subject and that such names as arithmetic, algebra and geometry have a definite meaning.
7. That there are special racial aptitudes for mathematical work along particular lines.

Other mathematical myths that have gained wide credence are also mentioned and, wherever possible, the origin of each myth is explained and reference to an authoritative source is made where it is discussed at greater length.

6. Murray, Walter I., "Deriving the Quadratic Formula." *School Science and Mathematics*, 38: 785–786. October, 1938.

The principle used in this derivation is that of the elimination of the middle term which Cardan used in his solution of the cubic. The author recommends that his derivation be given after the simpler treatment has been presented and the students thoroughly understand the meaning of quadratics. It is an especially valuable method for rigorous treatment to be presented to the more advanced high school students either in the class room or in the mathematics club.

7. Smith, David Eugene, "On a Remarkable Contribution to the History of Mathematics." *Scripta Mathematica*, 5: 77–82. April, 1938.

Unlike Professor Miller (see 5 above) the writer of the article under review believes that Bell's *Men of Mathematics* "deserves a place in the library of every secondary school, college and university and in every teacher's study. The pages and the binding will soon decay but not the impressions which the contents will leave upon its hundreds of readers."

8. Staniland, A. E., "Art in Mathematics." *Scripta Mathematica*, 5: 101–109. April, 1938.

The author believes that mathematics as an art is "distinct from poetry, distinct from painting, distinct from music, yet none the less an art by reason of its own essential quality and its power to command esthetic appreciation." He then proceeds to justify his conception of mathematics as an art by stating a definition of the word "art" and by showing that mathematics satisfies that definition.

9. Trustram, S. F., "That Dull Subject, Mathematics." *The Mathematical Gazette*, 22: 250–254. July, 1938.

The following are some of the pedagogical devices the author has found useful in livening up his classes in mathematics:

In arithmetic the pupils are permitted to handle actual stocks and bonds that have very small value, of course. Dozens of exercises can be made up from these stocks and bonds and they will be of greater interest to the class because they are of actual financial transactions. Floating a company to buy out the school Stamp Club is another device that can be used to interest the student.

In algebra, the author flashes a copy of a radio magazine with a page full of formulas to still any question about the use of algebra. In learning graphs, the pupils are more interested in statistics of road accidents, local gas consumption, etc. than in those of imports and exports, rainfall and temperature.

Hints and effective methods of teaching geometry and trigonometry are also given.

10. Volpel, Marvin C., "Solid Geometry Made More Interesting." *School Science and Mathematics*, 38: 740–742. October, 1938.

Before any one of the students in the class of solid geometry was permitted to write his final examination he had to submit a semester project. Some of the projects follow: Solid Geometry on the Farm, Solid Geometry in the News, Solid Geometry in Architecture, etc.

"The assignment was made for the following purposes: (1) to set the boys off on a piece of research work of their own choice; (2) to find out how solid geometry is related to life; (3) to afford a leisure time activity; and (4) to find out what opportunities are available for correlations with solid geometry."

Two boys became so interested in the picture of Taj Mahal that appeared in their textbook that they constructed a model of the famous mausoleum. Another boy made a study of different kinds of architectural columns. A twenty-pointed star, built upon an icosahedron as a base, was also submitted.

"At the close of the course an exhibit of these projects was made. Needless to say these objects attracted much attention and created much interest among the members of the student body."

To New Subscribers

We are unable to supply the October issue of *The Mathematics Teacher* to a great many of our new subscribers who wanted it because orders to begin with that number have been so great that our supply is exhausted. This affects so many people that we are notifiying them through these columns rather than by writing to each one separately.

NEWS NOTES

"Instructional Procedures for the Slow and Bright Pupil" was the theme of the morning meeting of the all day sessions of the Illinois Association of the National Council of Teachers of Mathematics at the annual meeting this fall. The following aspects of the problem were discussed in ten and twenty minute talks:

"Generalizations in Plane Geometry for the Bright Pupil"—Frank Allen Thornton Fractional Township High School, Calumet City.

"Testing the Slow Pupil in Plane Geometry"—Mary LeMay, Ottawa Township High School, Ottawa.

"Securing Effective Pupil Participation in Class Activity"—Agnes Nelson, Urbana High School, Urbana.

"Illustrating Mathematics"—Blanche Raman, Lanphier High School, Springfield.

"Presenting the Verbal Problem"—Mae Blair, Pekin Community High School, Pekin.

"Teaching Algebraic Fractions"—Selma Farha, Quincy Junior High School, Quincy.

"Teaching the Guessed Average Method"—Anice Seybold, Monticello Township High School, Monticello.

"Report of the Sub-Committee on Ninth Grade Mathematics"—E. H. Taylor Eastern Illinois State Teachers College, Charleston.

The afternoon meeting was devoted to the following addresses:

"The Preliminary Report of the Commission on the Place of Mathematics in Secondary Schools"—Joseph A. Nyberg, Department of Mathematics, Hyde Park High School, Chicago.

"Techniques of Teaching Mathematics to the Slow-Learning Pupil"—Professor Raleigh Schorling, Head of the Department of Mathematics in the University High School, University of Michigan, Ann Arbor.

The Cleveland Mathematics Club started its series of meetings for 1938–39 with the following programs:

October 21, "The Place and Character of Mathematics in Junior and Senior High Schools," Mark C. Schinnerer and E. J. Bryan, assistant superintendents of schools.

November 18, "Modern Trends in the Teaching of Arithmetic," Dr. R. L. Morton, Ohio University. Dr. Morton is chairman of the National Council of Teachers of Mathematics Committee on Arithmetic, whose report was published in the October issue of THE MATHEMATICS TEACHER and is available in reprint form.

Because of the two-day sessions of the National Council at the Hotel Carter in Cleveland on February 24 and 25, local activities of the club will be resumed March 24 with an open forum discussion.

The club will make a pilgrimage to Oberlin College on May 20. Dr. W. D. Cairns of the Oberlin faculty will address a dinner meeting. Election of officers also will be held then.

Any teacher in the Cleveland metropolitan area who is interested in mathematics is invited to join the club. The meetings are open to the public. Teachers outside the Cleveland area who wish to obtain information about the club's meetings may obtain it from the officers. They are: A. Brown Miller, president, Fairmount Junior High School; Helen Baldwin, vice-president, John Hay High School; Mary E. Barhyte, secretary, James Ford Rhodes High School; and J. J. Rush, treasurer, West High School.

The Minneapolis Mathematics Club has scheduled the following speakers and topics for discussion in their 1938–39 program:

William Carlson, Principal of the University High School, "Life in Greenland."

Dr. Charles C. Weideman, Ohio University, "Teaching of Mathematics" (illustrated).

Dr. Dunham Jackson, University of Minnesota, "Place of Mathematics in Education."

Dr. Charles Boardman, University of Minnesota, "English Public Schools."

Dr. L. J. Brueckner, University of Minnesota, "Potential Effect of Current Promotional Practices upon Secondary Curricula."

Newton H. Hegel, Principal of the Folwell Junior High School, "The Mathematics Strand in Junior High School."

L. N. McWhorter, Assistant Superintendent of Schools, "Personal Side of Personnel."

LYDIA D. THOMPSON, *Secretary*

The North East Iowa Teachers' Association met in Cedar Rapids, on September 30. Miss Alice Rudd of Cedar Rapids was chairman of the mathematics round table in the afternoon at which the following program was given.

"How We Use Mathematics" theme: "In Commercial Studies," L. M. Becker, Dubuque

Senior High School; "In Art," Leon A. Zeman, Franklin Senior High School, Cedar Rapids; "In Chemistry and Physics," John Bliese, Cedar Falls High School; "In Manual Arts and Drafting," A. J. Peterson, East High School, Waterloo; "In Social Studies," Superintendent A. B. Grimes, Monticello; "In College," Professor Alfred W. Meyer, Coe College, Cedar Rapids; "A Survey of Mathematics by High School Graduates," W. E. Owen, Roosevelt High School, Cedar Rapids; "A Mathematics Club Which Helps Care for Individual Differences," H. Vernon Price, University High School, Iowa City.

FLORENCE M. MOLES, Wilson High School, Cedar Rapids, Ia.

The following persons attended the meeting of the National Council of Teachers of Mathematics on June 27, 28, and 29, 1938 in New York City:

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*Mayberry, Alice C.
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Plumb, Valworth
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Barkley, Grace E.
Pueblo
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*Prageman, Helen
Roth, Friedrich
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*Noyes, Mary
Fairfield
*Sanford, Charlotte
Hartford
*Shanok, Casper
New Britain
*Fuller, Kenneth G.
*Weeber, Margaret
New Canaan
*Irwin, John R.
New London
Newton, Fred L.

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*Slade, Katherine
Urbana
*Katra, Adolph E.

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South Bend
*Kitson, Mary
Vincennes
Dunn, O. L.

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*Beito, E. A.
*Hunter, Lottchen Lipp

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*Jones, Edwina

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Baton Rouge
*Lawrence, W. A.

MARYLAND
Baltimore
*Herbert, Agnes
*Norris, Grover Wm.

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*Ryan, James D.
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Martin, Margaret L.
Fitchburg
McConnell, Mary
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*Sander, Benjamin C.
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Whitney, Alfred G.
Worcester
*Daley, Katherine

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*Adams, Wilma
*Loss, Nellie
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*Reese, Dora W.

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*Schuster, Leona

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Imlaystown
*Dyjak, Kathryn
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Scheideberg, Philip
Leonia
Bloss, Rowend
Smith, Doris
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Lane, Kathleen
Lyndhurst
Hansen, Anne
Tait, Marion
Madison
*Osteyee, George
Montclair
*Fehr, Howard
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*Mallory, Virgil
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*Orleans, Joye

Girls' Commercial High School
*McQuade, Rose
*Rosenberg, Rose

Grover Cleveland High School
Eisner, Stanley
Reuper, Ruth

Haaren High School
Adler, Irving
Turtz, Rose

Harriet Beecher Stowe Junior High School
Myers, Veronica

Herman Ridder Junior High School
Ginsburg, Abraham

High School of Commerce
*Braverman, Benjamin
Robinson, Robert

High School of Music and Art
Anderson, Anna
Engel, Celia
*Grosberg, Samuel
Zalosh, Hyman

Hunter College
Allegri, Linda
*Wood, Meta

Inwood Junior High School
*Silverman, Minnie

Jamaica High School
Bay, Theodosia
Bernard, Rose
*Howard, Lucy

James Monroe High School
*Berenson, Sarah
*Hausle, Eugenie
Klinkerfuss, Nelle
*Silberstein, Nathan
Weiss, Rose

Julia Richman High School
*Arnold, David
Lehman, J.
Palevsky, Lillian
Tarr, Matilda

Junior High Schools
Beatty, Ann
*Larity, Catherine
Shaw, Lena
Weiss, Junior

Junior High Schools in the Bronx
Coblenz, Harriet
Moran, Elizabeth
*Wakelee, Harriett

Junior High Schools in Manhattan
Anopol, Rose
Cohn, Madelon
Fisher, Virginia
Houske, Margaret
Miller, Ruth Ray

Manhattan High School of Weight
Ruderman, Ruth
Cutler, Muriel

McKee Vocational High School
*Elfers, Richard

Metropolitan Vocational High School
*Cincotti, Julia
Morris, Cohen

Morris High School
Eynon, Mrs. Hazel
Paul, Mabel
*Shapiro, Marie

Murray Hill High School
Gordon, David

Newton High School
*Eaton, Clara
*Martin, Martha
Nadler, Maurice
*Rose, Anna B.
*Von Sothern, Fred

New York University
Celauro, Francis
*Drushel, J. A.
Payne, Charles
*Schutzman, William

Olinville Junior High School
*Rothenberg, A. Harry
*Young, Benjamin

Public Schools in the Bronx
*Abramsen, P.
Bergen, Daisy
Collins, Katherine
Fote, Miriam
Gaffney, Florence
Greene, Bertha
Kierman, Agnes
Nixon, Harriett
Riss, Estelle
Stanton, Estelle
*Wade, Olive
Walsh, Irene
Weiden, E.
Wein, Evelyn
Weitzen, Sylvia
Zimmerman, Martha

Public Schools in Queens
Cassidy, Theresa
Coe, Isabel
Ford, Lillian
Schultz, Constance
Weisenberg, Norris

Public Schools in Manhattan
Boyarsky, Meyer
Carone, Emanuel
Clark, Marion
James, Elvira
Foreman, Mary
Goalwin, Eva
Greenberg, Lenore
Curry, Katharine
Lesser, Sara
Melenthal, Rebecca
Perkins, Miss Annie
Polikoff, Anne
Rosenthal, Pearl
Rose, Raphael
Spitzayler, Eleanor
Williams, Willis

Richmond Hill High School
Kimball, Eva

St. Anthony
Sister Margaret
Sister M. de Chantal
Sister M. Rosalina
Sister Rosita

Textile High School
Kimbal, Alfred
*Molloy, Theresa
Noble, Eleanor

Stuyvesant High School
*Altwerger, Samuel
*Breckenridge, William
*Hethy, Walter
*Roslow, David
Sidofsky, Hyman

Teachers College, Columbia University
*Atherton, C. R.
*Bakst, Aaron
*Bakst, Eloise
*Elliott, Archie
*Reeve, W. D.
*Sutherland, Ethel

Theodore Roosevelt High School
Kuschner, Rose
Lustig, Emilie
McCormack, Joseph P.
Nomoff, Ellen
Young, Gertrude

Tottenville High School
Carroll, John

Wadleigh High
*Byrne, Margaret

Walton High School
Bierman, Lillian
*Cronin, Anna
Mullin, Margaret
Verrilli, Clara

Washington Irving High School
Baxter, Florence
Cohen, Jeanette
*Greenberg, Etta
Peterson, Elsie
*Roll, Rose
Weill, Wilma

Others from New York City
Albini, Joseph
Blumenreich, S. M.
*Buchsbaum, Shirley
*Clark, J. R.
Cohen, Blanche
Coleman, Robert
*Gravel, Martha
Haefner, Ralph
*Hertlin, Lillian
*Mirick, Helen C.
Naftalis, Judith
Parnass, Helene
Reeve, Mrs. W. D.

Shaw, Homer
*Sobel, Frances
Statsurger, Sarah
Strammer, Lillian
Laure, A. C.

New Rochelle
*Carroll, Grace
Strong, Ora

Oneonta
Kershaw, George

Port Chester
*Bain, Mary

Pough Keepsi
Cohn, Bernice

Ridgewood
*Simpson, Julia

Rochester
*King, Blanche
*Smith, Paul

Rockville Centre
Bowe, Mary
*Reeve, Alice
Tripp, Elma

Scarsdale
Austin, Evelyn

Solvay
*Burroughs, Bruce

Southampton
*Blythe, Marjorie

Spring Valley
*Sweeney, Kenneth

Staten Island
Feman, Harry
Hankin, Aaron
Hook, Edwin
*Wiseman, John

Tarrytown
Dolgenas, Marcy

Tottenville
Avery, Rhoda

Troy
*Wylder, Erma

Valley Stream
*Henry, Etta

Yonkers
Lennon, Roger

NORTH CAROLINA

Hot Springs
*Neumeister, Mildred

Misenheimer
*Madeiff, Emma

NORTH DAKOTA

Fargo
Sifritt, Grant

OHIO

Athens
*Emmert, Robert

Cadiz
*Adams, Henderson

Cincinnati
*Wuest, Alma

Cleveland
*Owens, Clifford

Columbus
Walsh, Frances

East Palestine
*Yoder, L. G.

Oxford
*Christofferson, H. C.

Shaker Heights
*Muller, F. Brooks
*Miller, A. Brown

Steubenville
*Boyd, Margaret

OREGON

Portland
Laber, Maurine

PANAMA

*McUary

PENNSYLVANIA

Bucks County
*Evans, Walter

Dillsburg
Durborau, Corace

Downingtown
Lemmon, Raymond

DuBois
*Knarr, Malinda

Mifflintown
*Rearick, Alice

Monessen
*Williams, E. Helen

Philadelphia
*Achitoff, Louis
*Constable, Mary
*Holbrook, Alice
*Rosengarter, Elizabeth

Red Lion
Reiner, Bessie

Shippensburg
Bellows, Charles
*Kieffer, Nora

Slippery Rock
*Rhoads, Margaret

State College
Smith, Ruth

Trucksville
*Saxe, Esther
Staub, Hilda

York
*Gulden, Minerva

PHILIPPINE ISLANDS

Dumaguete
Heflin, Josephine

RHODE ISLAND

Providence
Wallace, Madeline

TENNESSEE

Arlington
Wellborn, Margaret

TEXAS

Beeville
*Bell, Genelle

UTAH

Salt Lake City
*Gerberish, Mattiek

VIRGINIA

Gloucester Point
*Andertine, Mrs. I. M.
*Andertine, Mrs. L. Etta

Hampton
Sanders, Edna

Newport News
*Sinclair, Lucy

Portsmouth
Dashiell, Eleanor

WASHINGTON

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Anson, Esther

Seattle
Frahm, Ida

WISCONSIN

Marinette
*Thull, Margaret

WYOMING

Cheyenne
Williamson, Alice

Laramie
*Bacon, Glennie

* Signifies member
Members 43.5%
Non-members 56.5%

ATTENDANCE BY STATES

Australia	1	Michigan	4	Panama	1
California	6	Minnesota	2	Pennsylvania	18
Colorado	3	Missouri	2	Philippine Islands	1
Connecticut	10	Nebraska	1	Rhode Island	1
District of Columbia	9	New Jersey	44	Tennessee	1
Georgia	1	New York	326	Texas	1
Illinois	9	New York City	189	Utah	1
Indiana	3	Brooklyn	88	Virginia	5
Kansas	2	Other Cities	49	Washington	2
Kentucky	1	North Carolina	2	Wisconsin	1
Louisiana	1	North Dakota	1	Wyoming	2
Maryland	2	Ohio	10		
Massachusetts	7	Oregon	1	Total	482

The Iowa Association of Mathematics Teachers met November 4 at Drake University, Des Moines.

"A Mathematics That Functions" by Miss Martha Hildebrandt, Maywood, Illinois, opened the session. Miss Hildebrandt's address was followed by a business meeting, the report of the curriculum committee, a report of the work of the National Commission on the Place of Mathematics in Secondary Education, Dr. Ruth Lane, University High School, Iowa City, and "Greetings from the National Council," Miss Martha Hildebrandt, Maywood, Ill.

The following short talks were given by mathematics teachers from the high schools of Iowa: "A Unit Offering Background Matter for Arithmetic," Miss Ruth Davison, Riceville. "The Teaching of Mathematical Vocabulary," Mr. Harland H. Hanson, Arthur. "Use of the Newspaper in Teaching Junior High School Mathematics," Mr. Harvey Littrell, Algona. "A Brief Summary of the Keokuk Survey of Graduation Requirements and Programs of Study in Certain Iowa High Schools," Mr. George Nickle, Keokuk.

The Eastern Kentucky Education Association held its fifteenth annual meeting in Ashland on November 10, 11, and 12. The Department of Mathematics Teachers met the afternoon of the eleventh for the following program. Miss Myrtle M. Brown, Ashland Senior High School, presided.

Business Session, election of chairman for 1939. "The Adaptation of Courses in Mathematics to the Needs of the Individual at the Secondary level" (including an experiment under way in Fayette County), Colonel D. Y. Dunn, Superintendent Fayette County Schools. "My Impression of the Teaching of Mathematics in Europe and on the Continent," Dr. William S. Taylor, Dean, College of Education, University of Kentucky. Dean Taylor has just returned from a year's study and travel in Europe.

The University of Iowa Extension Division was host to Iowa mathematics teachers in the thirteenth annual conference in Iowa City, October 14 and 15. The following addresses distinguish the program.

"Geometry a Pattern of Clear Thinking," H. C. Christofferson, Miami University, Oxford, Ohio.

"Geometry for Those Who Ask What good is it?" or "The Laboratory Approach to Geometry," Henrietta Terry, University of Illinois High School, Urbana, Ill.

"The Use of the Publications of the National Council of Teachers as Reference Material," Edith Woosley, Sanford Junior High School, Minneapolis, Minn.

"On the Meaning of Best Approximation," Edwin N. Oberg, University of Iowa.

"Report on the Work of the National Commission on the Place of Mathematics in Secondary Education," Ruth Lane, University of Iowa.

"Visual Aids in the Teaching of Junior High School Mathematics," Edith Woosley.

"Functional Thinking in Mathematics," H. C. Christofferson.

"Use of the Pantograph and Planimeter in Teaching Ratio and Proportion," Henrietta Terry.

The fall meeting of the Connecticut Valley Section of the Association of Teachers of Mathematics in New England was held October 22 at the Oxford School in Hartford, Conn. The following program was given.

Social Gathering.

Welcome, Mrs. Vachel Lindsay, Headmistress, Oxford School.

"The Jewish Passover and the Christian Easter," Professor Bancroft H. Brown, Dartmouth College.

"New Angles in Trigonometry," Professor William Fitch Cheney, Connecticut State College.

Business Meeting.

"An Algebraic Approach to Plane Geometry," Mr. Gordon R. Mirick, The Lincoln School, New York City.

"Hints for Mathematics Classes," Mr. John A. McGuinn, Kingswood School.

Professor W. D. Reeve, Teachers College, Columbia University, addressed the Mathematics Section of the Southwestern Indiana Teachers' Association Annual Session, on October 27, in Evansville. Dr. Reeve's subject was "Curriculum Problems in the Teaching of Mathematics."

The Association's meeting extended over two days, October 27 and 28, with both general and departmentalized meetings and addresses.

The Southwestern Ohio Teachers Association's ninety-sixth meeting was held October 28 and 29 in Cincinnati. The mathematics department meeting on the afternoon of the twenty-eighth started with a luncheon. Cecil O. Tower of the Walnut Hills High School presided at the business meeting. Dr. W. D. Reeve, Teachers College, Columbia University, spoke on "Pressing Curriculum Problems in the Teaching of Mathematics.

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